MADRAS FISHERIES DEPARTMENT

BULLETIN No. 12

ADMINISTRATION REPORT, 1918–19

AND

THE OUTRIGGER CANOES OF INDONESIA

BY

JAMES HORNELL, F.L.S., F.R.A.I.

A STATISTICAL ANALYSIS OF AN INSHORE FISHING EXPERIMENT AT MADRAS, 1919

BY

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BY

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BY

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MADRAS

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ADMINISTRATION REPORT OF THE DEPARTMENT OF FISHERIES, MADRAS, FOR THE YEAR 1918–19.

BY

JAMES HORNELL, F.L.S., F.R.A.I.,
Director of Fisheries.

Madras, *the 21st August 1919.*

To the Secretary to Government,
Revenue (Special) Department, Fort St. George.

I have the honour to submit the administration report of the Department of Fisheries for the year ending 30th June 1919.

Administration.

2. *Administration and Personnel.*—With the sanction of Government, the Honorary Director, Sir F. A. Nicholson, handed over charge of the department to myself on 26th November 1918. Fortunately he was willing to remain for some time longer in charge of the West Coast fisheries stations, thereby greatly lightening the difficulties which confronted me in taking up the mantle of so exceptionally able an administrator. The department owes its origin and present industrial and economic importance entirely to his far-sighted initiative; my endeavour must be to continue and, if possible, amplify and extend the good work he has carried forward so far and so successfully in many directions. It is fortunate for me that I have been associated with him in many of his most important plans and experiments from the beginning, a fact that renders my path more easy.

3. Owing to the difficulties entailed by war conditions, officers to take over my duties as Marine Assistant and Marine Biologist were not at once available. In consequence I had to combine as well as I could the duties of Director with those of these officers till 1st March 1919, when Mr. J. H. Allan relieved me as Marine Assistant from duties which at present include the superintendence

of the pearl and chank fisheries [G.O. No. 278, Revenue (Special), dated 14th February 1919]. This officer has seen much service during the war, first in Mesopotamia as a Royal Engineer officer in the Inland Water Transport; being invalided out on account of injuries, he obtained, on recovery, a temporary commission in the Royal Naval Reserve, and was given command of a flotilla of six mine-sweepers based in Colombo. His experience in command of motor-launches and steam-trawlers combined with his previous record in all grades of the mercantile marine, fit him admirably for his new duties, and already he has been of great assistance to me.

4. No appointment to the vacant post of Marine Biollogist has yet been possible; a man with suitable qualifications and adequate practical experience is hard to obtain on the pay sanctioned, in view of the keen demand for zoologists of this type at home and in the Colonies, where fisheries' development is particularly active at the present time.

5. Under the reorganization scheme Messrs. V. Govindan and B. Sundara Raj reverted to their substantive posts of Assistant Director and Piscicultural Assistant, respectively; the office of Piscicultural Expert being abolished, the administrative duties are carried on by the Director, who also gives direct personal supervision to the technical side of the work. To relieve the Director of a certain amount of routine work, Mr. U. Karunakara Menon was appointed Personal Assistant and joined duty on 20th December 1918.

6. *Removal of Headquarters Offices.*—With the appointment of a whole-time Director, with headquarters at Madras, the old office at Chepauk, already much overcrowded, became impossible and removal to larger premises was imperative. By the courtesy of the Bank of Madras, a portion of their handsome new office in the Mount Road was placed temporarily at my disposal; removal thereto was effected on 7th April 1919. Unfortunately another move will have to be made before the end of this year, and so far, a suitable location has not been found. Much work, especially the scientific, is practically at a standstill under these unfavourable circumstances, for most of our reference books and specimens have to be kept in packing cases where they subserve no useful purpose.

7. *Director's Tours.*—Since my appointment, I have made extensive tours in Kurnool and Nellore on piscicultural duty; also on the East and West Coasts on general inspection and particularly

to select sites for several new Fishery Demonstration Stations under consideration. The initiation of the Marine Assistant into his duties necessitated several tours to the coast towns of Tinnevelly and Rāmnād. Calcutta was also visited in company with the Marine Assistant to inspect steam-trawlers under construction. Altogether I spent 148 out of 216 days on tour after becoming Director on 27th November 1918.

General.

8. *Limitation of Expansion.*—The limitations placed upon expansion consequent upon war conditions continued throughout the greater part of the period under review ; all existing lines of work pursued a normal course with results much the same as last year. It was not found possible to extend operations on any considerable scale. The only important departures consisted in the taking over on 1st June 1919, from the Salt and Abkāri Department, of a number of fish-curing yards on the West Coast to be run on model lines, in the reorganization of the old Aquarium taken over from the Museum authorities as per G.O. No. 387, Home (Education), dated 27th March 1919, and the initiation of a scheme for the education of men to become eventually the teachers in elementary schools in fishing villages, with a special curriculum appropriate to their occupational requirements. With a return to more normal conditions several important dormant propositions have been revived, and submitted for the consideration of Government, together with others entirely new. If we can obtain sufficient subordinates, the expansion of our activities should be rapid within the next few years, but unfortunately this presents great difficulty ; indeed I fear it will be unsurmountable till we have a technical institute or rather Fishery College, where the men we so urgently need will be able to obtain education in the theory and technique of their profession. An University education is a good foundation whereon to build ; alone, it is insufficient equipment for a fishery expert, even of subordinate rank.

The scientific assistance and advice of the department have been again in demand during the year by officers concerned with fishery development in several other States, notably Burma, Baroda, Travancore, and the Seychelles ; zoological collections have also been furnished to researchers in various countries including Australia, the United States and Java.

9. *Finance.*—Results judged by this standard may be considered eminently successful, for, apart from the industrial section comprising the cannery and fishcuring yards which will be reported upon separately, large increases in profits mark the operations of both the marine and fresh-water sections. The profit made by the former of Rs. 32,409-3-7 in 1917-18 has been increased to Rs. 74,722-2-3, chiefly by the better yield of the chank fishery, and the large expansion under the head of zoological supply. An increase of over Rs. 7,000 has also been obtained in the profits from the sale of fishing rights in rivers, canals and tanks, controlled and stocked by the department. Concurrently with these gratifying increases has to be noted the fact that expenditure actually shows a small decrease, that for 1918-19 (excluding 'Factories') being Rs. 1,96,073-14-0 as against Rs. 1,96,146-8-6 in the preceding year. It is not likely that such extremely favourable finance will continue indefinitely; expenditure upon research, education and socio-economics is likely to mount up rapidly in the immediate future. Meanwhile it is a matter for congratulation that the marine and fresh-water operations, even after bearing the debit for the supervision and research charges of the whole department, and excluding profits made in industrial experiments on the West Coast, have been able not only to pay their way, but also to show the substantial net profit of Rs. 35,447-0-7.

HONORARY SUPERINTENDENT'S SECTION.

10. This section, administered directly by Sir Frederick Nicholson, comprises practically all the work carried on by the department on the West Coast and might indeed be termed the West Coast Section. The sub-sections include the Beypore cannery, oil and guano operations, the experimental fish-curing yard at Tanur, the control of certain public fish-curing yards transferred from the Salt and Abkāri Department, and the important subjects of co-operation, education, and related socio-economic work among the fishing classes. The year's operations are surveyed by the Honorary Superintendent, and as this report is printed *in extenso* as an annexure, there is little for me to say, except to express my deep regret that the heavy burden entailed by supervision of this work, has determined Sir F. A. Nicholson to hand over charge at an early date. As one consequence of this

I have proposed to Government to appoint a General Manager to have charge of the Cannery with a view to systematize and develop operations. The appointment is now pending and I trust that, with a competent Manager continuously on the spot, the production may be largely extended in the immediate future. The experimental and research side will not be neglected; in this connexion the most promising line of work at the present time seems to be that in respect of the sharp freezing of fish. The fish trade in the leading fish-producing countries is particularly alive to this subject and from the experiments which both the Honorary Superintendent and myself have carried out, there is, I believe, a great sphere of usefulness in front of this particular subject in this country, provided ice can be produced sufficiently cheaply. But while these matters have the material progress of the fishing industry as their object, and may result in substantial direct profit to Government, the socio-economic aspect of our work is likely to prove of far greater eventual value to the community in the uplift it will bring to the fisherfolk of this land. I propose to extend vigorous propaganda in the immediate future to the East Coast fishing communities, and also to the fresh-water fishermen of our rivers and tanks. Two groups of these latter men, after lengthy discussions with the Piscicultural Assistant, have now grasped the value of co-operation in regard to joint action to eliminate the greedy middleman, and are eager to be banded together financially with a view to take over certain extensive fishing rights in the Cauvery at the termination of the present lease. Proposals are being prepared to this end; I trust this may be the beginning of a movement which will enable the department to deal directly with fishermen-groups in the majority of the fisheries now leased to the highest bidder, irrespective of whether he is a speculator or a fisherman.

The trading account of the Cannery and other industrial branches of work not having yet been received, will follow as soon as they come to hand.

11. *Inshore Fishing at Madras.*—The second season's work, sanctioned in G.O. No. 3741, Revenue, dated 23rd November 1918, commenced on 16th December 1918. Two additional canoes were obtained from Malabar with their complement of crews, nets and lines. The Assistant Director, under whose supervision and guidance the experiments were carried on, reports that "in 6½

months the crews were able to capture 83,187¾ lb. of fish which were sold for Rs. 4,912-0-9 at an average price of about 11·3 pies per lb. The largest quantity caught on a single day was 2,080 lb., worth Rs. 108-9-9. The total expenditure for the period is Rs. 5,320-1-1 including a capital outlay of Rs. 1,026-15-1 for canoes and nets. As the canoes are serviceable for about fifteen years and the nets for about three years, depreciations at 7 per cent and 35 per cent may be calculated respectively on their value. The effects of these operations on the local fisherfolk are not altogether unfavourable and, though none of the well-to-do among them has yet come forward to copy our example, we have been able to secure the services of four local fishermen to work in our canoes and this is a great improvement considering the opposition that was set up by them last year. Unfortunately our men had again to incur the displeasure of some of the local men as they assisted the Marine Police in capturing smugglers who were carrying 2,000 tolas of opium into a steamer in the harbour. On several days when only a few catamarans were able to go for fishing owing to bad weather, our canoes went out and were able to land good hauls of fish, e.g., on 16th January 1919, they captured 1,715 lb. worth Rs. 91-5-0 though only a few catamarans went out fishing on that day. Important biological information and other data have also been recorded." Supervision charges, amounting to Rs. 434, have not however been debited, but this is justifiable in part, if not entirely, by the fact that if a party of fishermen were working in co-operation on their own account and profit there would be no need for paid supervision. A point which the report of this experiment omits to note is that a considerable amount of fishing was done inside the harbour where no local fishermen are allowed to ply their calling. This is a most material circumstance; therefore to present a perfectly fair account of the result of these operations, it is necessary to deduct from the receipts whatever sum was received from the sale of fish caught inside the harbour. This amounted to the comparatively large sum of Rs. 828-14-3. Deducting this amount and depreciation of Rs. 201-3-1 on boats and nets making in all Rs. 1,030-1-4, from the gross receipts of Rs. 4,912-0-7, we have a balance of Rs. 3,881-15-3 as against Rs. 4,293-2-0 (excluding supervision), leaving a loss of Rs. 411-2-9 on the working. From this there may however be deducted the sum of Rs. 169-7-3, which represents the rail fares incurred in transporting

the crews from West Coast. Even with this extra deduction a final net loss of Rs. 241-11-6 has to be faced. Hence I am afraid that the results are not sufficiently encouraging to induce local men to change their methods.

The exposed and surf-beaten nature of the Coromandel Coast makes improvements in fishery methods extremely difficult, and except at harbours such as Madras, Negapatam, Cocanada and a few other places, we cannot hope to replace the catamaran by any better type of sea-craft. At Tuticorin and Negapatam, I hope soon to start experiments having for their object the introduction of larger and more efficient fishing craft, such as the fine balance-board boats of Tirupalagudi and the roomy weatherly fishing type used on the Bombay coast. Experiments in long-lining are even now in progress at Tuticorin and these will be reported upon in due course next year.

Marine Section.

12. This section was wholly in my charge for the first eight months of the year; thereafter the Marine Assistant took over the departmental fisheries and the care of the department's fleet. The duties come under the following sub-heads:—

Chank and pearl fisheries, the bêche-de-mer industry, the marine fish-farm, the oyster park at Pulicat, the marine aquarium at Madras, zoological supply to colleges, research and miscellaneous.

13. *Departmental Fisheries.*—These, which include the chank, pearl and bêche-de-mer fisheries, proceeded normally so far as the first and last are concerned. The second proved again wholly unproductive, neither adult pearl oysters nor spat being found anywhere on the banks. The chank fishery was specially remunerative partly because of increased catches, but chiefly by reason of the increased rate (Rs. 325 per 1,000) received under the new contract for the Tinnevelly shells. The total catch of chank shells was 435,262 shells as compared with 391,137 in the previous year, while that of bêche-de-mer was 208,610 against 58,927 in 1917-18. During the year all the chank fisheries usually rented out, were re-leased to the highest tenderer in each case, satisfactory rates in all instances being obtained, notably so in that of the Chingleput and Nellore fisheries which are now leased for three

years at the rate of Rs. 1,250 per annum as against Rs. 600 previously, a most satisfactory advance. The former Tanjore lessee, however, defaulted in part, in his final year's payments, paying Rs. 4,100 only against the sum due of Rs. 5,922. The new lease is for a term of three years at the rate of Rs. 4,466-10-4 per annum.

14. *Financial Results.*—The year's work has been most successful and can best be expressed in tabular form as under :—

	Expenditure.			Revenue.			Profit.		
	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.
1. Tinnevelly Pearl and Chank Fisheries.	27,194	13	2	49,944	0	4	22,749	3	2
2. Rāmnād Chank and Bêche-de-mer fisheries.	34,651	4	11	76,221	12	7	41,570	7	8
3. Sivaganga Chank Fishery.	242	1	0	342	2	8	100	1	8
4. Tanjore Chank Fishery.		...		4,100	0	0	4,100	0	0
5. South Arcot Chank Fishery.		...		1,886	8	7	1,886	8	7
6. Nellore and Chingleput Chank Fishery.		...		750	0	0	750	0	0
7. Ceylon Chank Fishery	4,649	4	1	7,862	1	2	3,212	13	1
Total ...	66,737	7	2	1,41,106	9	4	74,369	2	2
	Deduct supervision charges ...						6,789	1	11
				Net profit ...			67,580	0	3

In addition to the above receipts the sum of Rs. 14,250 was received by the sale of the engine of the *Lady Nicholson.*

The above profit is the largest on record derived from our chank fisheries and is due in the main to the abnormally high price being paid under the current contract for the Tinnevelly chanks, which is Rs. 325 per 1,000 shells as against Rs. 121 per 1,000 for the preceding three years. The total *net* profit on the year, Rs. 67,580-0-3, compares most satisfactorily with that of last year which was Rs. 39,278-5-9. It would have been considerably greater had it been possible to enlist a larger labour force at Tuticorin or had the season been normal in regard to weather.

15. The financial aspect of the minor revenue-producing branches of our marine work is shown as follows :—

	Expenditure.			Receipts.			Profit.		
	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.
Marine Fish-farm ...	864	12	4	937	9	9	72	13	5
Pulicat Oyster Farm ...	1,820	15	3	1,930	13	3	109	14	0
Zoological Supply ...	363	4	8	1,257	14	6	894	9	10
Marine Aquarium ...	2,063	14	6	3,807	11	6	1,743	13	0
				Total Profit ...			2,821	2	3

Except in regard to the first of these, the above profits are most gratifying, particularly that in respect of Zoological supply which is more than double the profit of the fourteen months ending 30th June 1918.

16. *Tinnevelly Chank Fishery.*—The year's catch of 148,285 is not up to the average of late years but it compares well with the 126,377 fished in 1917–18. The weather conditions were good in the early part of the season and a bumper catch was anticipated. Unfortunately in the most productive period, January to April, the weather was unsettled and this, taken together with a virulent outbreak of cholera which carried off two of our best divers, was the cause of the comparatively poor result of the fishery. The number of crews working regularly was six, the same as the preceding year. Government in G.O. Mis. No. 1858, dated the 13th May 1918, had sanctioned an increase in the rate paid for shells of three pies each, equivalent to an increase of 50 per cent over former rates, partly to meet the increased cost of living and partly to render the divers' calling more popular. The poor catches made owing to unsettled weather largely counterbalanced the advantage given ; I fear also that the increased rate, in too many cases, tends to irregularity in working, for when a good catch occurred, it was often the case that some divers failed to turn out to work the following day. The concession given has not been gratefully received by the majority of the men, whose appetite for more pay and a consequent increase in ' off-days ' has materially increased of late. Intemperance and the consequent squandering of earnings are at the bottom of the trouble ; so far as possible the department endeavours to counteract these evils by means of the departmental coffee stall, by personal suasion and the organization of temperance lectures. These have had a good effect upon some of the

younger men, and for this we have to be thankful. Further and more definite steps in this direction are now under consideration.

17. On account of the poor earnings of the Tuticorin divers in 1918, and the low market rates prevailing in Calcutta this year (1919) for Ceylon shells, I decided not to send our usual expedition to fish in Ceylon waters. A further reason was that a local speculator, without experience of the trade, began to recruit our divers for the same purpose. He made large advances and extravagant promises of pay far beyond what current rates warrant. With adverse conditions reported from Ceylon—extremely high food prices and epidemic diseases—the project has fallen through, at least temporarily, and the divers, after an attempt to coerce the department into extravagant concessions, using the high pay promised to them in Ceylon, as a lever, are now veering round and agreeing to our terms. This incident, and the unreasonable attitude of the divers in face of the concessions given and help rendered to them in the past in many ways, emphasize how precarious is the present system of exploiting our chank resources, where the success of our work depends upon the whims and fancies of ignorant men, easily misled by any specious talker.

For various reasons no outside diving labour, with the exception of two Arabs, could be recruited. Special attention will be given next season to this subject, as it is increasingly necessary to supplement the local labour available from outside sources.

18. *Rāmnād Chank Fishery.*—Results show a steady progressive improvement on the preceding two years. The total yield from the various fishing centres during 1918–19 is shown below in comparison with 1916–17 and 1917–18, viz. :—

	1916–17.	1917–18.	1918–19.
Rāmēswaram	158,942	192,252	205,305
Kilakarai and South Vedalai...	16,295	17,295	16,326
Pillaimadam, Jadhi quality ...	9,175	22,410	36,561
„ Patti „ ...	...	3,851	6,050
Tirupalagudi, including Sivaganga.	69,809	28,952	22,735
	254,221	264,760	286,977

19. The fishery at Rāmēswaram proceeded unusually smoothly. None of the usual difficulties of recruitment was experienced; the Kilakarai merchants were not anxious to take their men to

Ceylon this year because of the lowness of the Calcutta market, except on terms much less favourable than usual to the divers ; in view of the high prices of foodstuffs in Ceylon, the divers could not accept any reduction in terms. So an adequate diving force for our local needs was obtained without difficulty. A number of the Kilakarai men have abandoned chank fishing this year in favour of ordinary fishing and others have emigrated to the Straits ; had these men joined the fishery the catches of shells at Rāmēswaram would have been considerably higher. The fishery was favoured with good weather and lasted for a period of 65 days, from 27th February to 2nd May, without interruption from any cause. The diving force numbered 400, manning 43 canoes ; of these approximately 300 were from Kilakarai and the vicinity. The total number of undersized shells brought ashore was 27,263, of which 17,029 were returned alive to the sea. It continues to be difficult to prevent an undue quantity of these shells being fished, and this is a matter where tact and firmness in the subordinate staff are essential.

20. As last year, the steam launch *Eider* was chartered for the busy period of the season, from 5th March to 10th April. The cost amounted to Rs. 4,214-4-7 as against Rs. 3,000 last year. Increase in the prices of coal and supplies and a rather longer period of employment, account for the increase. In the latter period of the fishery when the number of canoes decreased, the launch *Leverett* brought from the West Coast for the purpose, took over this work, and enabled us to dispense with the employment of the *Eider*, so effecting a large economy. Without efficient towage, this fishery cannot be run satisfactorily.

21. From the experience gained during the past four years, it is clear that 200,000 shells may be taken as the normal annual yield to be expected from the Rāmēswaram beds ; if considerably more be fished, there is likely to be a diminished catch in the following year and thereby an inducement to the divers to insist on a relaxation of the minimum size limit in order to make good the deficiency in full-sized shells. We may therefore base our estimates in future regularly upon a two-lakh catch at this centre.

22. The North Vedalai or Pillaimadam section continues to develop most satisfactorily, beds not fished for a number of years being now given increasing attention by the divers. This is due directly to the increase given in the rate for the fine quality shells

(Jadhi grade) fished here; this has rendered it remunerative to the local men to fish the neglected beds situated a greater distance from Vedalai, and has also, during the past year, induced a number of Kilakarai men to fish at Vedalai instead of going to Ceylon towards the close of the Rāmēswaram fishery. The increase in the catch of *jadhi* and *patti* qualities together is 16,350 over 1917–18, viz., 42,611 as against 26,261, a most notable rise. The Vedalai men at present are the divers most contented and most regular in work.

The Kilakarai catches were normal, but those at Tirupalagudi again showed a decrease. The shells fished at the latter place are the poorest quality of any fished departmentally and at present are difficult to sell in Bengal, where the adverse economic conditions among the lower classes make the purchase of chank bangles a luxury that has in many cases to be postponed till normal conditions return. Hence the weakness of the market for poor quality shells. I believe there are very large accumulations of such shells in Ceylon, practically unsaleable. No Valampuri (sinistral) shells were fished at any centre during the past year.

23. *Sivaganga Chank Fishery.*—The lease of this fishery having expired on 30th June 1918, a new agreement was concluded with the Sivaganga Estate, whereby the Madras Government lease the fishery for a term of five years for an annual rental of Rs. 120. The yield of the fishery was 2,266 shells only, distributed as follows:—

Karangadu	791
Mullimunai	609
Pudupattanam	724
Tondi	46
Miscellaneous	96
	2,266

The expenses, including rental, amounted to Rs. 242–1–0, whereas the value of the shells is Rs. 342–2–8, yielding a net profit of Rs. 100–1–8.

The fishery is a poor one, the beds being very scattered and difficult to fish as well as poor in yield. Few divers live in the Sivaganga villages, most of them having abandoned chank fishery in favour of net-fishing for fish and crabs on account of the poor yield of the chank fishery. The chief reason for controlling and working the fishery is to prevent persons using the Sivaganga

villages as bases for illicit operations under cover of fishing the Sivaganga beds.

24. *New Works.*—A second set of divers' lines was completed during the year at Rāmēsvaram, giving much needed accommodation to the divers attending our camp. The crews of ten canoes can be housed in these new lines. The cost was Rs. 1,540. Part of the original set of lines was also converted into an office and storeroom at a cost of Rs. 418-2-10, thus enabling us to dispense with the rented buildings hitherto occupied—a convenience as well as an economy. A small chank godown costing Rs. 150 was erected at South Vedalai, on the land acquired in the preceding year.

25. *Ceylon Fishery.*—A fleet of nine canoes manned by sixty-three divers and ten mundaks was despatched to Ceylon in two batches during July and August of 1918, to participate in the Ceylon Fishery. Whereas all the divers in 1917 were recruited at Tuticorin, in 1918 four crews joined from Rāmēsvaram. The results attained were not satisfactory in any way, save that these men were given employment at a time when remunerative work at home was practically unobtainable. The total catch was 51,370 full-sized shells and 8,419 under-sized and wormed, confiscated. Fishing was possible on forty-one days only, the weather being broken and unsettled, with turbid water for most of the time the men were away. South-west winds continued much beyond the normal season and in greater violence than usual. The season was altogether abnormal and unfavourable. Add to this that influenza prevailed in the camp during the latter part of the season, incapacitating many of the divers just at the time when better weather began. The poor catches entailed by these untoward conditions, conjoined with the excessively high price of rice at Jaffna—two measures only per rupee—made existence difficult for the divers and entailed grumbling and discontent. The average cost of provisions was Rs. 9-8-0 per month per man, so if his earnings be calculated at Rs. 15 per month, he had Rs. 5-8-0 only to send to his family in India— a sum manifestly insufficient.

The rate given, Rs. 75 per 1,000 shells, was governed by that paid by the Kilakarai and Jaffna merchants; this was Rs. 13-8-0 less than the 1917 rate, in consequence of the depressed state of the Calcutta market for this class of shell.

The shells brought back remain unsold. They have been offered for sale twice, but so far the best offer has been Rs. 105-10-0

per 1,000, against Rs. 155 obtained last year. It has been decided to hold the shells till the market recovers.

26. *New Chank Contracts.*—As the Ramnad chank contract expired on 30th June 1919, public tenders for the produce of the fishery for a period of three years from that date were called for. The offers showed a great falling off compared with those made three years ago. The highest was that of Mr. Hem Chandra Kar, who tendered Rs. 215 per 1,000 for Rāmēsvaram shells, Rs. 161 per 1,000 for Kilakarai quality shells, Rs. 101 per 1,000 for Tirupalagudi shells and Rs. 101 per 1,000 for the jadhi and patti shells fished off Pillaimadam and North Vedalai. In view of the depressed condition of the Calcutta market his tender was accepted. Although the rates are much less than those of the expiring contract, the main rate, that of the Rāmēsvaram quality, compares satisfactorily with Rs. 140 per 1,000 received in 1915–16 for the same shells. The lower prices will, it is hoped, go some way to help the banglemakers in Bengal to meet the difficult situation which now confronts them, owing to the falling off in demand owing to the inability of the poorer classes to afford luxuries.

27. The lease of the Tanjore Chank Fishery expired on 28th February 1919, with a debit balance of Rs. 1,822 still owing by the lessee. Legal proceedings are now being taken to recover the amount. Tenders for a new term of three years were called for and the highest bidder, M. K. Periatambi Marakkayar Sahib, has been awarded the lease; the rent to be received is Rs. 4,466–10–4 per annum. Considering the state of the market, this rate is a highly satisfactory one.

The South Arcot Fishery has also had to be re-leased owing to the default of the former lessee. It has now been rented for Rupees 1,546–2–6 per annum for a period ending 30th June 1922, an increase of Rs. 46–2–6 per annum on the previous rental.

The Chingleput and Nellore fishery which has been held by M. K. Periatambi Marakkayar Sahib since its revival in 1914, was obtained by S. Abdul Qadir Sahib in public competition for a further period of three years from 1st July 1919 on an annual rent of Rs. 1,250, an advance of Rs. 650 per annum on the previous rental. Such a large increase is most gratifying and is concrete proof of the value of what, a few years ago, was a neglected asset of Government. The three leased-out fisheries have now been brought to a satisfactory state of development.

28. *Pearl Bank Inspection.*—No detailed inspection was possible, but the principal banks were visited and tested with the help of the motor launch *Sutherland*; no deposits of oyster spat were found anywhere. A thorough examination of the banks is arranged to take place next season.

29. *Bêche-de-mer Fishery.*—As a means to keep the chank divers together by affording them an opportunity to earn money when chanks are scarce, this industry was continued at Tirupalagudi in the usual manner of previous years. The quantities fished were as follows :—

	1918–19.			1917–18.		
			LB.			LB.
Large size (Nos. I and II).	13,145	weighing	675	39,520	weighing	1,710
Small size (No. III).	195,465	,,	2,844	19,407	,,	431
Total ...	208,610	,,	3,519	58,927	,,	2,141

The bulk of the No. III size was obtained in April, May and June of this year; all these are immature individuals, under one year old and should be left on the beds to grow to adult size. Unfortunately the Fisheries Act of 1897 does not provide for the protection of any immature marine animals of economic value and till it be amended, a pressing necessity, we have to stand helpless and watch the destruction and waste of valuable food materials. Were these immature bêche-de-mer left unfished another year, the product would increase three-fold in weight and some five-fold in value. As it is, if we did not allow our divers to fish the immature, some outside merchant would step in and perpetrate much greater havoc; we *do* discourage the fishing of the very smallest and reject a considerable number in order to emphasize our views. It appears that conditions have been specially favourable to the propagation of bêche-de-mer during the past year, and the quantities of young are so great that I trust enough will be left unfished to give a bumper fishery of adults next year.

30. The same great abundance of young has been found in the inshore grounds north of Rāmēsvaram Island, and this abundance, coinciding with a sharp rise in prices in Singapore and Penang, induced two Rāmēsvaram merchants to resume the industry in April and May 1919. I had originally intended to carry on the

work departmentally, but as the merchants had certain claims upon the allegiance of the Rāmēsvaram divers because of long outstanding advances, I agreed to forego my plans on receiving a promise to pay satisfactory rates to the divers and to cure the material in a proper and cleanly manner. I am glad to report that this has been done and that they have now over three tons of excellently cured stuff ready to ship. The prosecution of this fishery at Rāmēsvaram has materially assisted the chank fishery, as it induced many men to continue work much longer than they would otherwise have done, chanks and bêche-de-mer in this locality existing side by side. It is noteworthy that the bêche-de-mer fished by our divers at Ceylon is notably larger and heavier than our best, fished in the south-west corner of Palk Bay; all our larger Indian material is really No. II grade in regard to size.

Fishing is still proceeding actively and the good catches made have proved a godsend to the divers of Tirupalagudi; nearly Rs. 1,000 has been expended in cash in the village on this item alone, apart from the much larger sum received for chanks fished at the same time. As nearly all the material was fished in the present year, it will not be sent to Singapore for sale till September when the fishing season will be ended for this year.

31. *Krusadai Island Biological Station.*—Government sanctioned in their Order No. 640 W., dated the 17th May 1919, the modified scheme mentioned in the preceding year's report. According to this new scheme the old hospital building will be converted into halting quarters for the Marine Biologist, whilst a modest biological laboratory and establishment quarters will be erected adjacent, at a total estimated cost of Rs. 5,790. The revenue from coconuts, water-supply and the lease of the right to collect cowries and other shells, chanks excepted, amounted to Rs. 63-6-10. No material increase can be expected till after the completion of the station, when an effort will be made to develop the agricultural resources of the island.

32. *Tuticorin Fish Farm.*—The greater part of the works necessary to transform the Silvathurai lagoon at Tuticorin into a true fish-farm has been completed, but the sea-mouth remains to be closed. I do not anticipate the Public Works Department will be ready to hand the works over before September. In the meantime ordinary fishing is carried on vigorously. The quantity of fish caught increased considerably, but the prices obtained

were less remunerative than in the year before; concurrently the wages bill increased; hence the profits were largely decreased. Comparison with the results of the preceding period reported upon is misleading as the latter covered a 14 months' term and included extraordinary miscellaneous receipts of Rs. 276–6–0. If the receipts from catches alone be compared of the past three years (actual) we get the following data :—

	1916-17.				1917–18.				1918–19.			
	LB.	RS.	A.	P.	LB.	RS.	A.	P.	LB.	RS.	A.	P.
Prawns ...	7,306	769	5	0	7,487	737	1	6	7,446	632	11	9
Fish ...	2,262	121	0	9	3,837	201	12	10	4,623	264	6	9
Crabs ...	...	30	0	0	...	38	0	0	...	39	11	9
Total ...		920	5	9		976	14	4		936	14	3

(Miscellaneous receipts are omitted.)

These figures show remarkable consistency from year to year, and their average may be accepted therefore as an accurate index of the revenue to be obtained from a sheet of water of this extent in the undeveloped condition. The possession of these data will be of the utmost importance in future when the lagoon is worked as a cultural proposition; it will enable us to judge of the utility or otherwise of rearing sea-fish in confinement. The profit made was Rs. 72–13–5 on an expenditure of Rs. 864–12–4 for wages and nets. The line fishermen as usual obtained notable benefit from the supplies of prawn bait we were able to provide; a new development was the taking up of the crab fishery with our own staff. Simple though this is, we had great difficulty in persuading our men to do this; crab fishing is the monopoly of two or three low caste men and ordinary fishermen were averse to attempt it. Eventually traps were obtained and the staff instructed and somewhat to their surprise they found the work easy and catches as good as those made by the professional crabbers. We have now trained half a dozen men to the work and catches should increase considerably in the coming year.

33. *Pulicat Oyster Park.*—Operations were carried on as usual. Demand increased notably, particularly from the hotels in Madras, Bangalore and Secunderabad. From 1st July 1918 to 30th June 1919, 404,850 oysters were supplied as against 99,100 for the corresponding period last year. The steady progress made in

this section of our activities during the past three years is well brought out in the following tabulations of receipts and expenditure :—

	1916–17.				1917–18 (14 months).				1918–19.		
	RS.	A.	P.		RS.	A.	P.		RS.	A.	P.
Expenditure	805	10	0		1,124	5	9		1,820	15	3
Receipts	459	9	6		843	6	6		1,930	13	3
Loss ...	346	0	6	Loss	280	15	3	Profit	109	14	0

Not only has the volume of business increased greatly, but the loss experienced in both the two preceding years has now been converted into a profit.

The difficulties attendant upon the comparative inaccessibility of Pulicat continue however to hamper progress greatly, and sometimes to cause disappointment to consignees. When the Ennur Fisheries Station be re-established as intended during the current year, supervision will become more efficient and the operations will be facilitated in several ways.

34. *Zoological Specimen Supply.*—This branch of our operations has been attended with remarkable success during the past year. A new price-list was prepared and circulated among the principal colleges in India, with the result that orders have poured in steadily and tax our modest resources to the utmost. The following comparison shows the financial aspect of the work :—

	Expenditure.			Receipts.			Profits.		
	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.
1917–18	302	11	11	735	11	0	432	15	1
1918–19	363	4	8	1,257	14	6	894	9	10

Considering that the rates charged are much lower than those of the Plymouth and Naples laboratories, and that we are not seeking to make large profits, these figures are noteworthy and reflect credit upon the Sub-assistant in charge of this branch. It has to be remembered too, that this particular work, like so much else, is done under very great disabilities. We have not a properly fitted up marine laboratory anywhere, and this cannot be remedied pending the erection of the long postponed Marine Stations at Madras and Krusadai Island (Pāmban). The fact remains that we are now able to supply the Zoological Departments of Indian Colleges and Universities with the greater part of the specimens they require for teaching purposes and which formerly they had to obtain at

heavy expense from Europe. As was noticed in last year's report, the bulk of the orders come from the north of India, where zoological teaching appears to be far more vigorous than in the south. The Benares University sent particularly heavy indents.

35. During the year I drew up a scheme for the reorganization of school museums in respect of that part of their collections representative of the fauna of our seas. At present there is no order or system in these collections; their educational value is low and it is rare indeed to find any of the specimens identified and labelled. To effect a remedy and to place adequate means to teach 'nature study' and marine zoology at the disposal of teachers in secondary schools, I have proposed to the Director of Public Instruction to provide series of standard zoological collections arranged systematically. The contents would comprise sets of typical Indian sponges, corals, and other cœlenterates, sea-urchins, starfishes, sea-worms, shell-fish, crustaceans and fishes, together with the minor groups, with special exhibits illustrative of various outstanding habits and phenomena among marine animals, such as parasiticism, commensalism, protective colouration, degeneration, etc., etc. This was welcomed by the Director who proposes to arrange for the sets to be taken by a large number of schools, provided handbooks to the collections be written. This condition I have accepted and as Government have approved of the scheme, I hope to write these handbooks at an early date.

36. *The Madras Aquarium.*—Government having been kind enough to sanction the proposals which I had made to this end [G.O. No. 387, Home (Education), dated the 27th March 1919], the Aquarium at Madras was transferred from the charge of the Superintendent of the Museum to that of the Director of Fisheries on 1st April 1919. With the help of the Zoological Assistant (Mr. S. T. Moses), I have been able to effect many improvements which add greatly to the attractiveness of the exhibits. Sanction has also been obtained from Government (G.O. No. 790 W., dated the 14th June 1919) to instal electric lighting in the building, so that it will be possible to admit the public in the evenings. The tanks will be lit from above, an arrangement which will convert each tank into a fairy-like sea-grotto far prettier than its daylight appearance. Electric fans are also to be installed in the central hall to moderate the heat of the day in hot weather. Advantage will be taken of the installation to fit an electric motor to the air compressor used

in aerating the tanks. Consequent largely upon the improvements introduced and the greater variety of fishes exhibited, the attendance returns increased wonderfully during the three months that 'Fisheries' have had control. The attendance jumped from 21,354 in the months of April, May and June of 1918, to 35,422 for the corresponding period of the present year; the receipts during these months in 1918 were only Rs. 762-14-6 as against Rupees 1,540-11-6 for the same period this year. Rupees 21 were also obtained from the sale of guides as against 13 annas only in 1918. Still more gratifying perhaps is the fact that, whilst the takings have not only been doubled, this has been done without increasing expenditure. Indeed this has been materially reduced, the expenditure for the last three months of 1917-18 being Rs. 470-10-6 as against Rs. 405-13-7 in the present year.

The statistics for the whole year compared with those for the preceding year are as follows:—

	1918-19.			1917-18.		
Total number of visitors	96,957			93,409		
	RS.	A.	P.	RS.	A.	P.
Total admission money	3,783	4	6	3,336	2	6
Total expenditure	2,063	14	6	2,020	3	8
Profit ...	1,719	6	0	1,315	14	10

An entirely new handbook to the aquarium has been written by the Director and this will be issued at an early date (G.O. Mis. No. 1341, dated the 12th July 1919).

37. With the cessation of the war, it has become possible to revive the project of an enlarged aquarium with laboratories attached, where zoological research may be prosecuted under really favourable conditions. A committee is now engaged in investigating the merits of the possible sites which have been proposed.

38. *Research.*—Lack of any adequate facilities for laboratory work and still more the fact that the post of Marine Biologist has not yet been filled up, have handicapped this section of work most woefully. However the Director was able to complete a very voluminous and important report upon the fishing craft of Indian seas, a subject which has never received detailed attention until the present time. The report is now in the press and will be issued as one of the memoirs of the Royal Asiatic Society of Bengal. A second, upon East African fishing craft, has appeared

in the London Journal *Man*. Another memoir upon the relationship of Madagascar and East African outrigger fishing craft with those of Indonesia has also been completed and will probably be published in one of the French scientific journals. Much material for other work of a similar nature has been collected; the value of research of this character is important because of the light it sheds upon the relationships of coast populations in the east.

The anatomy of the chank (*Turbinella pirum*) has been worked out in detail by the Zoological Assistant and should shortly be in a condition for publication. The life-history of a curious shore-frequenting beetle, *Bledius maindroni*, has been investigated by the Fish-farm Sub-Assistant, who is also collecting extensive details concerning the life-history and growth of the chief backwater fishes of important food value.

38-A. *Edible Seaweed.*—A certain amount of edible seaweed is found on the Rāmnād coast and islands, of the kind sold in Colombo under the name of 'Kalpentyn moss.' This is used largely by Muhammadans in making a gelatinous sweetmeat and should be equally adapted for refinement into agar-agar, which is in considerable demand in Europe, especially for bacteriological purposes. To test the market value of the Rāmnād product in the European market this department collected 500 lb. and arranged with a firm in Tuticorin to export it to London. The firm have promised to report the result. The cost of collection was paid for in full by the exporters.

39. *The Department's Fleet.*—The opportunity afforded by the strengthening of the staff by the appointment of a Marine Assistant whose duties will be entirely executive as apart from research, has enabled me to have the whole of our little fleet properly overhauled. The motor engine of the *Lady Nicholson*, being found to develop less speed than is requisite, has been sold for the very satisfactory price of Rs. 15,000, less 5 per cent commission. It will now become necessary to decide whether it is desirable to instal a more powerful engine; estimates are being sought from several well-known makers. Opportunity was taken at the time of removing the engine to overhaul the vessel and effect the necessary repairs. The hull is now in perfect condition.

The motor launches *Pearl* and *Sutherland* are now under repairs and minor alteration. The *Leverett* performed useful towing service during the Rāmēswaram chank fishery and has proved

most serviceable owing to her high speed and fine towing power. Her consumption of oil is heavy however and compares unfavourably with that of the semi-Diesel 'Dan' engines in the *Pearl* and *Sutherland*. The fishing lugger *Turbinella* is being refitted for deep-sea fishing experiments to be carried on off Tuticorin and Negapatam.

40. *Experimental Trawling.*—The proposals to obtain a sea-going steam vessel able to carry out experimental trawling off Cape Comorin, along the Malabar Coast and north of Madras have been revived and are now under investigation. The Marine Assistant and I under instruction from Government inspected three steel trawlers now under construction by Messrs. Burn & Co., Calcutta, and three composite mine-sweepers built at the Indian Marine Dockyard, Kidderpore. None proved suitable, the former being without sufficient cabin accommodation and the latter with inadequate deck space for trawl operations.

Inland Piscicultural Section.

41. Soon after assuming charge of the Directorate I arranged to take over the direct control of this section, Mr. Sundara Raj reverting to his substantive post of Piscicultural Assistant. In this, however, he has now much more responsibility than originally ; he has charge of the whole of the executive work and his duties include the drafting of the details of new schemes after the main lines have been decided upon by the Director. Extensive tours have been made by myself in Kurnool, Nellore and North Arcot, and by the Piscicultural Assistant and his Sub-Assistant in these and other districts.

42. *Fish-farms and Acclimatization.*—We have at present three piscicultural establishments where fish for the stocking of tanks and other waters are bred. These are at Sunkesula, Ippur and the old Powder Factory in Madras. Others at Chingleput, Mopad and Vellore are contemplated. The fish upon which efforts are now being concentrated are the Gourami and *Etroplus suratensis*. The Gourami (*Osphromenus gourami*) is an exotic species foreign to India, but much esteemed in Java where it is bred in large numbers. It has been introduced with notable success into the ponds and streams of Mauritius. We have now breeders obtained both from the latter island and from Java and these are distributed among the three fish farms at present available.

Complete success has attended our efforts to breed from them at Sunkesula and the Powder Factory ponds, but at Ippur, where much larger areas of water are at our disposal, breeding has not taken place. From the information I gained during my visit to Java last year, I am inclined to suspect that the Gourami is not likely to succeed in tanks of large area; it seems a fish that thrives best in quite small ponds where there is much vegetable growth and shelter: it offers analogies to the domesticated animals and will, I fear, not be a success in India except in ponds of moderate extent. It is essentially a species that requires personal attention to secure its well-being; hence the high hopes which attended its introduction into Madras are, I fear, likely to be disappointed. But I may be mistaken in this deduction, and so far the evidence either way is not sufficient. We shall therefore go on with the experiments till we make sure of the facts; at Ippur where the Gourami have not yet bred, though they have been there for over two years, I am arranging for the ponds to be reduced in size and for an increase of water plants therein.

43. *Etroplus suratensis* is the other fish on which our hopes largely centre. It is indigenous to the waters of the Presidency, but has a comparatively limited distribution in backwaters and certain tanks near the coast line. It is found, for instance, in the Adyar, Fort St. George moat, and the large Kalavoy tank at Chingleput. The two former are often highly saline, whereas the latter is purely fresh water. Yet *Etroplus* lives and breeds equally well in all these: this peculiarity is of the highest value obviously in piscicultural work, particularly as this fish has a good flavour and attains a fair size in a comparatively short time. It breeds freely and as it attaches its eggs by preference to the underside of stones where these are raised free from the pond bottom, it is easy to construct suitable nesting places for the breeders. By this device *Etroplus* has been induced to breed prolifically at Sunkesula and at Ippur and in the Powder Factory ponds.

44. One of the common Indian mullets, *Mugil troscheli*, found abundantly in the tidal waters of our creeks and rivers, has also been introduced in the fingerling and fry stages in fairly large numbers to a number of fresh-water tanks with a view to increase the food value of these waters. The species in question readily adapts itself to changes in the salinity of its habitat and appears to acclimatize readily in perfectly fresh water. Whether it will

breed there is doubtful, but it is only by experiment on a large scale that this can be settled conclusively. Several thousands of young have been transported from brackish water to various tanks. Considerable difficulty was found in conditioning and transporting them safely, but this has been overcome in great measure by a series of experiments conducted at the Ippur Fish Farm.

45. *Sunkesula Fish Farm.*—The routine of this farm, which consists of rearing quick growing carp and other indigenous fish for the stocking of the tanks supplied from here, and in the breeding of Gourami and Etroplus for the same eventual purpose was carried on as usual. On my inspection, I found that the area available is altogether insufficient, nearly all of the large ponds originally provided for, having been allowed to dry up, on account of the difficulty of supplying them with water. I consider that the work of the farm cannot be satisfactorily carried on in these circumstances and I have sketched out certain improvements, consisting chiefly in the deepening of the abandoned ponds, which are now under investigation by the Executive Engineer of Kurnool. Owing to the failure of the monsoon last year, and the consequent unusual silting of the Tungabhadra river-bed adjacent to the farm, unprecedented difficulties were experienced last February and March in obtaining an adequate supply of water, even for the few small ponds which are now utilized. To guard against similar occurrences in future, a new well with a long infiltration gallery, has been sunk near the head sluice of the Kurnool-Cuddapah canal. Government sanction (G.O. R. No. 149, Financial, dated 2nd June 1919) was accorded and the well is now under construction by the Public Works Department at an estimated cost of Rs. 500. As mentioned before, both Gourami and Etroplus bred freely here; 53 young Gourami were transferred successfully to Ippur while 964 young Etroplus were distributed to selected tanks in the Ceded districts and to the Kurnool-Cuddapah canal. Supplies of live fish obtained from the growing grounds at Edurur and elsewhere were regularly forwarded by the Farm staff to the supply ponds at Kurnool, and therefrom delivered to the contractor. The total amount so supplied was 1,743 lb. of carp and other fish, and 105 lb. of murrel, the whole realizing the sum of Rs. 208-5-6. The two ponds at Kurnool for storing live fish pending sale, have been completed and will afford increased facilities for this useful work of supplying the public market with

live fish during the season when fish caught by the usual methods are scarce or unobtainable. A most satisfactory feature is that the contract for 1919–20 has been let at rates nearly double those paid for fish supplied on last year's agreement; this indicates increasing appreciation by the public of this convenience of getting fish at times when usually none are obtainable. The new rates are 5 annas per seer for murrel and 4 annas per seer for carp and other fish.

The Pudur scheme sanctioned in G.O. No. 920, Revenue, dated 28th March 1917, for the construction of ponds to rear young Gourami bred at Sunkesula, has had to be abandoned. The investigations of the Executive Engineer, Kurnool, proved that it is not possible to impound the water necessary except at great cost (vide G.O. Mis. No. 140, Revenue, dated 27th January 1919). Certain gullies along the Kurnool-Cuddapah canal are now being investigated in conjunction with the Executive Engineer, with a view to turn them into Gourami ponds to take the place of those which the Pudur scheme was intended to provide.

46. *Ippur Farm.*—Ninety young Gourami, partly from Sunkesula and partly from Madras, and 200 Etroplus from Madras, a fish new to this locality, were placed in the ponds for breeding purposes. None of the old Gourami have yet bred at Ippur, and it is evident that unfavourable factors are present. As at Ippur artificial nesting places for Etroplus have been provided in the shape of supported stones, and the device has proved successful. Over 30,000 of the mosquito-larvæ-destroying fish *Haplochilus* were supplied from this farm, which is the chief centre for their distribution.

The Gudur and Karedu tanks are supplied with mullet conditioned at this farm. Another aspect of the work done from this centre was the fishing departmentally of the Puduparthi and Ippur Kamini tanks; the produce yielded the satisfactory sum of Rs. 41–3–6 in place of the nominal sum of Rs. 5 received on an average in previous years when the fishing was auctioned publicly.

47. *The Powder Factory Ponds* at Madras continue to give highly satisfactory results. Both Gourami and Etroplus breed freely here. In the absence of suitable feeding grounds near Madras, 37 young Gourami were transferred to Ippur, together with 200 Etroplus. In addition ten permanent tanks in the Presidency were stocked

with young Etroplus from these ponds. A number of thick shelled river-mussels of a large species from Dacca *(Lamellidens daccaensis)*, obtained through the courtesy of Dr. B. Prasad, Acting Director of Fisheries, Bengal, have been stocked on one of the ponds, with a view to introduce them into this Presidency, where no species exists having a shell thick enough for button-making.

48. *Anti-malarial Operations.*—These form a considerable and valuable part of our work and consist of three separate phases, viz.:—

(*a*) The breeding and distribution of mosquito larvicidal fishes to municipalities and other public bodies.

(*b*) The periodical stocking of pools in specially malarious localities with such larvicides.

(*c*) The conversion of mosquito-infested sheets of water into fish-breeding ponds which also serve the purpose of fish-distribution centres for the stocking of irrigation tanks with young fish.

49. Regarding the first of these, I regret to record that in spite of the earnest recommendation of Government, municipalities and other local authorities do not as yet avail themselves at all adequately of the facilities for obtaining a good strain of larvicides from this department. They appear either careless in the matter or depend upon local supplies of what too often are species of very inferior larvicidal quality. Only some 30,000 of these fishes were in consequence distributed, a number totally disproportionate to the needs of the province in this respect. The Sanitary Inspector of the Madura Municipality was given a course of training in these operations and advice and instructions were given in numerous other cases, both to local officers and to private individuals.

50. In the second category are the *Cuddapah* and *Nallamalai schemes.* With regard to the former, operations have not yet been possible as the jungle road from Pallamadugu to Paddagadi is still under construction. As to the Nallamalai work, the bungalow sanctioned in G.O. No. 391, Revenue, dated the 10th February 1917, has at last been completed. The Collector's advice and approval have been obtained regarding the construction of additional ponds near Mahanandi for which proposals will be submitted to Government shortly.

51. *Chingleput and Vellore Moat Schemes.*—The schemes in this category comprise at present proposals for the conversion of the moats around the Chingleput and Vellore forts into fish farms to

provide breeding and rearing ponds for suitable fish, particularly Gourami and Etroplus, for the stocking of a large group of tanks within a considerable radius of each of these new farms. These moats at present form stagnant pools, largely overgrown with dense pond vegetation, supremely suitable as harbourage to mosquito larvæ. As a consequence malaria is endemic within both forts, an extremely serious condition seeing that a large reformatory for boys is located within the Chingleput fort, while the Police Training School is similarly situated within that of Vellore. When I visited the latter in April, I found parts of the moat so overgrown with water-lilies that the collection of their leaves for use as food platters was rented out; other portions, even where the water is deep, are even more densely choked with enormous masses of Water-Hyacinth, here well deserving its name of the 'lilac-devil'; mosquito larvæ live here in myriads and are the main cause of the malignant malaria that scourges the residents within the fort. The present position is that a revised and final estimate for the Chingleput works, amounting to Rs. 11,450, is now before Government, awaiting sanction, while in regard to Vellore, Government have given general approval (G.O. No. 3592, Revenue, dated 4th November 1918) to the proposals submitted for a combined anti-malarial and piscicultural scheme. The moat has been inspected and estimates have just been received from the Executive Engineer; the scheme will cost approximately Rs. 16,000.

52. *Departmental Tank Fishing.*—Plans for improvements in the methods employed by the local fishermen on the banks of the Kanigiri-Duvvur reservoir have been perfected and have received the sanction of Government [G.O. No. 1087, Revenue (Special), dated 29th May 1919]. This reservoir is one of the largest irrigation tanks in the Presidency and holds a permanent supply of water. Owing to their primitive methods and implements the local fishermen are unable to fish it except in abnormal years of drought. The result has been that the average fishery rental brought in a very small amount, out of all proportion to the intrinsic value of the fish content of the tank. The scheme sanctioned provides for the continuous fishing of the tank departmentally; the local professional fishermen (numbering 24), as opposed to those who occasionally fish, but whose occupational calling is not fishing, will be taken into the department's service, and new methods of fishing will be taught to them. A sum of Rs. 8,740 is sanctioned

for the provision of the necessary buildings which will include a model fish market, with boats, nets, and other apparatus, and Rs. 6,000 as annual running charges, over a trial period of three years. We have already accumulated a considerable amount of information respecting methods for fishing deep water tanks from experiments made during the last two years at Chembarambakkam tank. From these it appears that drag-nets and seines are of most value where the water is sufficiently clear of weeds for their use, and the bottom free from boulders; in the deep central portion, gill nets give good results when their mesh is suitable for the size of fish most abundant. This work is of great economic value in the development of our inland fisheries, for the customary plan of postponing the fishing of tanks till they are on the eve of drying up is most wasteful, resulting on the one hand in a dearth of fish for sale so long as there is plenty of water present, and on the other of throwing an excessive quantity on the market during several successive days in one single month in each year. We desire to regulate this and to spread the catch fairly evenly through a period of at least several months' duration.

53. *Mopad Scheme.*—A somewhat similar scheme has been evolved for the fishing of the great irrigation reservoir at Mopad, Nellore district, now on the point of completion. This great sheet of water, formed by damming the river Manneru, will impound a large body of permanent water. It is proposed to introduce into it good varieties of food fishes, with a view in later years to stock an extensive series of other tanks in the district with the fry obtained from the introduced fish, and also regularly to net a proportion of the larger fish for sale in neighbouring towns and villages. Detailed plans and estimates have been submitted to Government for sanction.

54. *Acquisition and Stocking of Tanks.*—As part of the routine work of the department, a large number of acquired tanks in the districts of Kurnool, Bellary, Anantapur, Salem, Chingleput, Chittoor, Nellore and North Arcot are stocked annually from our existing fish farms, as also is the Kurnool-Cuddapah canal. As a consequence, the rentals received have increased considerably since the date the tanks were taken over, and this forms our most important asset and source of profit in inland operations. As shown in statement No. IV the rentals received from these artificially stocked waters exceed by Rs. 7,889-14-4 the amount of compensation

payable by the department to the District Boards. In addition a profit of Rs. 23,425-13-0 was made last year upon the rentals of the Cauvery-Coleroon river system, after making full allowance for compensation. This amount of profit shows the satisfactory increase of Rs. 1,534-13-0 upon the 1917-18 figures. The total profit on this part of our work for 1918-19 amounts to the handsome sum of Rs. 31,315-11-4 as against Rs. 23,691 in the preceding year. I am desirous that this phase of our operations shall include the whole available tanks of a suitable nature in the Presidency at as early a date as possible. The Piscicultural Assistant is being given all the opportunity possible to press on with his survey of tanks in the different districts; I have also decided to have the work done systematically, district by district, rather than to pick out specially favourable tanks here and there as was the system previously. Accordingly effort during the past six months has been concentrated upon the Nellore and Chingleput districts, with the result that a complete scheme covering all the good tanks at present available in this area has been sent in to Government for sanction. I propose next to take Ganjām district as the tanks there are specially numerous as well as eminently suited to our purpose.

55. *Fish Hatcheries.*—The trout hatchery at Avalanche has, for the present, been transferred to the control of the Collector of The Nilgiris; this head will in future disappear from this report.

At the Hilsa hatchery at the Lower Anicut, no operations were possible last year owing to the failure of floods in the Cauvery due to the weakness of the south-west monsoon. Great numbers of ripe hilsa accumulated in the estuaries unable to ascend the rivers; these fell an easy prey to the local fishermen and hilsa roes were particularly abundant in the fish-curing yards on the Tanjore coast, Muthupet in particular. This year floods arrived early and ripe hilsa were found at the Lower Anicut as early as 25th July (1919).

56. *Fishery Regulation and Conservancy.*—The customary notification under section 6 (4) of the Fisheries Act of 1897 was a prohibitory order against all fishing in waters to which it was not applied, and, as this was not considered satisfactory, a modification is now made to permit fishing by lessees [G.O. No. 567, Revenue (Special), dated 27th March 1919] under which modified order, the fisheries of the Cauvery-Coleroon were notified for the first time under section 6 of the Act named above; this will in future enable the prosecution of poachers to be instituted and will, it is hoped, result

in increased fishery rentals being offered, as the lessees will benefit materially from the protection offered. On the representation of the Forest Department, a section of the Yelleru river, called *Kullathiri*, was inspected and as it was found to be an important breeding ground, Government have agreed to conserve the fishery under the usual section of the Fishery Act [vide G.O. No. 519, Revenue (Special), dated 22nd March 1919.]

57. *Deputation to Hyderabad.*—The Piscicultural Assistant inspected the Oosman Sagar tank, Hyderabad, at the instance of His Exalted Highness The Nizam's Government and a detailed report was submitted by him, with recommendations as to the measures to be taken to render its piscicultural value greater.

58. *General.*—A considerable amount of data is being accumulated concerning the distribution of fresh-water fishes and water plants; in the latter work we are benefiting by the valued assistance of Prof. Fyson who is kindly identifying the specimens submitted to him. Experiments are also in progress to determine the relative values of different kinds of artificial fish food, such as groundnut and gingelly oilcake (poonac), etc., the best species of mullet to use for introduction into fresh-water tanks and the best methods to employ in conditioning and transporting them. Due to the success of these latter experiments some of the Nellore and Chingleput tanks were stocked for the first time with mullets. Experiments in mussel culture have also been initiated at Sunkesula and Madras.

59. In concluding the survey of the department's activities in this section I cannot close without expressing my satisfaction with the good and earnest work put in by the Piscicultural Assistant, Mr. Sundara Raj, who has performed his duties most intelligently and energetically. The staff generally have also worked well and deserve commendation, but I regret to say that in nearly all cases their qualifications, so far as the executive section is concerned, are not adequate to requirements. This renders the burden of the Piscicultural Assistant so much the harder and this unsatisfactory state of affairs cannot be remedied till we have a technical institute for the training of the executive staff.

60. The usual statements and statistics are appended.

ANNEXURE No. I.

Report by the Honorary Superintendent upon the West Coast Experimental Station for the year 1918–19.

In November 1918 Mr. J. Hornell was appointed Director of Fisheries, the Honorary Director, with the name of Honorary Superintendent, retaining only the work of the West Coast which then included—

(1) the experimental cannery at Chaliyam (Beypore);

(2) the experimental fish-curing at Tanur;

(3) co-operation;

(4) education and other socio-economic work;

(5) fish oil and guano operations, including the supply of fish oil to the Munitions Board;

(6) fish-curing yards.

2. *The Experimental Cannery.*—This worked as usual but was sadly hampered both by the war conditions and by the poor supply of fish. Owing to the war, developments, e.g., in the purchase of plant for improvements were impossible; the stock of tin plate having been exhausted this essential had to be locally purchased at prices three times higher than in 1914 and even 1915, and for plate of greatly inferior size, weight and quality insomuch that the solderless plant could not be utilized for such plate. Solder went to about double the pre-war price, and proper packing oils were almost unobtainable, olive oil in quantity being out of the market, cotton-seed oil unprocurable, and superior ground-nut oil only available at nearly treble the normal prices. Fortunately a priority certificate for tin plate was obtained early in the year 1918, and the tin plate was delivered in the autumn which so far relieved the situation; the delivered price of this supply was about double that of the 1915 parcel. Notwithstanding these extraordinary items of cost, the sale price of goods was not raised above that of 1917–18.

3. As regards fish difficulties, the sardines were very abundant but generally of miserable canning quality, the size being so small for the greater part of the season that fish were packed at perhaps 36 to the tin instead of 11 or 12. These immature fish gave poor results in canning, being lean and comparatively bony; so much so that for some time I stopped canning them, though abundant.

4. Again, mackerel were comparatively absent from that part of the coast (South Malabar) and only 9,716 cans could be packed notwithstanding all exertions, and the end of the year has left us with almost a nil balance

of this favourite article. Prawns also were singularly absent, so that only 2,030 cans of whole prawns were packed and were entirely disposed of.

5. Notwithstanding difficulties, we packed 80,267 cans of all sorts during the year plus the opening balance, and sold 62,095 ; the closing balance on 30th June 1919 was 37,683 valued (cost price) at Rs. 9,683.

6. The expenditure during the year, was Rs. 34,285 including Rs. 5,644 on capital account and Rs. 28,641 running charges. The capital charges include Rs. 3,852 for building decent quarters for the staff; Chaliyam being only a small village, largely fishing, the staff had nowhere to live, and were not only gravely uncomfortable but were exposed to serious risks of disease. On part of the land obtained from the Forest Department (G.O. No. 118, Revenue, dated 8th January 1918) comfortable lines close to the cannery and away from the village have now been built.

7. The running charges were not only swollen, as stated above, by war-time prices, but include the cost of 15 tons of the high priced tin plate from England, much of which (135 boxes value Rs. 7,918, equal to about one year's consumption) remains in stock and is therefore available, without further expenditure, for 1919–20; also solder worth Rs. 1,485 and labels sufficient for about a year, are in hand.

8. The cash returns paid to the treasury were Rs. 27,641, or Rs. 6,644 short of drawings. This shortage is explained by the capital expenditure and by the heavy cost of the large parcels of English tin plate, solder, etc., mentioned above and largely still on hand; there are also additional assets of Rs. 1,853 as good debts for goods sold, and Rs. 12,773 being value of other goods and stores on hand, mostly the balance canned goods (Rs. 9,683 valued at cost price) from the year's work.

9. The gross profit on the year's work was Rs. 8,464–14–1 as per trading account. Deducting Rs. 4,110–0–6 on account of overhead charges (proportion of the Honorary Superintendent's travelling allowance, pay of all permanent staff—sub-assistant, mechanic, maistris, and office) and depreciation, etc., on buildings and plant, the net profits are Rs. 4,354–13–7. These figures are subject to super-audit. The profits are smaller in amount than in 1917–18 partly owing to the enhanced cost of material, partly to the year being the usual twelve months year instead of fifteen months as in 1917–18.

10. Little work could be done in experiments other than those of canning operations, owing to war conditions and the consequent impossibility of obtaining plant, metals, etc. An experiment in canning sardines rather more salted than usual in *large* tins in oil, so that a shopman could open such tin (kerosene or smaller) and sell canned sardines by the pound, etc.,

was tried with success ; cans thus packed and processed were subsequently opened and left open for many days without tainting, it is therefore now possible to give consumers in towns the benefit of tasty canned fish at very low rates. The experiment will now be continued and attempted with other sorts of fish.

11. The vacuum drier was run successfully in so far as thoroughly drying—over-drying—the fish, but it requires long and patient experiment to obtain results which will warrant larger ventures. I continue to believe in its possibilities as a rapid means of drying fish at minimum temperatures and with the loss of moisture only. This must be left for my successor.

The refrigerator was practically not in use.

12. The solar oven was worked as usual, the maximum temperature obtained being as high as 325° F. It continued to bake our lacquered cans.

13. *Tanur Experimental Yard.*—Very little needs special record about this yard, where the unfortunate conditions as to fish mentioned in paragraph 2 supra, also obtained ; sardines were abundant but very small, mackerel and prawns very scarce, though the prawns, as usual at Tanur, have recently been fairly abundant. Only about 90,269 lb. of fish were obtained for curing, costing Rs. 2,369 : those were cured and sold for Rs. 3,878. For oil and guano operations 237,411 lb. or about 106 tons were obtained at a cost of Rs. 613 (slightly below Rs. 8 per ton) the produce of which in oil and guano was Rs. 2,173, which after deducting the cost of fuel, labour, wear and tear, left a fair profit ; this would have been far greater had the fish been larger and more oily. The guano was sold at just Rs. 81 per ton, viz., 21¾ tons for Rs. 1,765, the weight of guano to raw fish being just above the normal 20 per cent. The leanness of the fish may be gauged partly from this last fact (for rich, oily fish usually give slightly less than 20 per cent dry guano), and more precisely from the product in oil which did not much exceed 4 tons on 106 tons of raw fish or 4 per cent ; double this rate is about normal, on a year's working.

14. A pair of twin refrigerating tanks was constructed at the yard in view to experimenting in the sharp freezing and in the chilling of cheap fish such as sardines. For various reasons, including difficulties about ice, the experiment has had to stand over to the current year.

15. The experimental work done in this yard should bear fruit in the application of the results to the ordinary fish-curing yard of which six were experimentally taken over from the Salt Department by Fisheries on 1st June.

16. During the year a great quantity of oil was supplied for the Munitions Board, mainly by purchase : the Tanur mechanic, M. P. Krishnan, was largely employed as an oil and guano expert on this business under the Assistant Director's supervision.

17. The Tanur accounts show a profit this year of Rs. 2,163. This takes into account profits of Rs. 2,736 on account of purchase of oil for the Munitions Board, etc., partly by the Tanur Staff. But this latter is not strictly a profit obtained by the ordinary operations of the yard. Deducting this sum the Tanur yard will show a small net loss of Rs. 573. The loss would have been converted into a profit had there been larger purchases and sales especially of oil and guano, but as stated in paragraph 15 the results are not directly pecuniary but in improvements in general fish-curing, etc., in the future.

18. *Co-operation.*—This in its details was carried on entirely by the Assistant Director. At the beginning of the year there were ten co-operative societies, based on thrift, of which nine were on the West Coast and one on the east : they had about 900 members and Rs. 10,400 as own capital. During 1918–19 no less than 32 new societies, of which 29 were on the West Coast, were organized ; of these 26 were registered and got to work ; two of these were societies for the production and sale of cured fish, fish oil and guano. All of these except two were directly organized by the Fisheries Department. The newness of these numerous societies has, of course, brought down the average of members and capital which recently stood at about 1,900 members ; it is noteworthy that 256 of these were females, the women of the fisherfolk being co-workers with the men in industry and especially in curing and selling. The 'own' (actually paid up) capital was Rs. 25,388, and loans had been given for over Rs. 40,511, of which 8,736 were paying off usurious debt. Deposits were small since the members have subscribed their own cash, but Rs. 4,714 had been borrowed from central banks.

19. Owing to very serious outbreaks along the coast of cholera, small-pox, and influenza, this work was seriously hampered and several even of the older societies temporarily ceased active business ; otherwise more would have been done. Nevertheless the proportion of societies to the fisher population is about 1 in 5,300.

20. It is to these societies that we look for the general development in status, independence, and intelligence of the fisherfolk and for their financial regeneration ; it is only among an awakened population that we can hope to introduce the fishery developments on which work has begun in Tanur and elsewhere, and to enable them to take their place as free fishermen.

21. Part of the year was spent in inculcating the advisability of co-operation in the sale of fish oil and guano. There have been and will increasingly be demands for large parcels of oil by arsenals, jute mills, etc., and if the isolated producers—isolated in fact though there may be a dozen in a village—combine as members of a co-operative society, it follows that, commanding large parcels, the society can sell to advantage direct to large consumers and thus evade the middlemen or if they sell through or to a middleman, can fix and obtain equitable prices. Moreover since arsenals and factories, etc., often require high class oil, it will pay the members of a society to manufacture such oil and obtain the consequent better prices. On the other hand the consumer obtains large parcels of even quality in one transaction, and, avoiding the middleman, can give or obtain better terms. With guano it is the same; if societies bulk their products and have them tested, planters, associations, etc., can deal direct for large parcels and can demand a guarantee of quality; this will make for better goods and check adulteration.

22. Two such societies have begun to work on these lines under inducement from this department, such inducement being backed by considerable purchases by the department for the Munitions Board, arsenals, several large planters, etc. It is hoped to see this business developed during the current year.

23. The Thalayi (near Tellicherry) co-operative curing-yard for which Government have granted direct aid, only began work in May at the very end of the season: even now it is not completed.

24. *Education.*—This was a notable year in this matter. In the marginally-noted Government Orders is recorded the history of and proposals for the scheme devised for ordinary fisherfolk education, that is for education other than the special technical and scientific education of an advanced Fishery Institute. The Director of Public Instruction approved of the scheme which was sanctioned by Government; a Training Institute for the special schoolmasters, who under the scheme have varied duties to perform, has been also sanctioned, a Headmaster appointed and work begun, in a preliminary way, on the 14th July 1919. Several primary schools already started by private agencies in certain villages have been taken over, and inquiries made regarding trial schools in several other villages. The history of fisherfolk education, village or otherwise, is in the future.

G.Os. No 16, Home (Education), dated 3rd January 1917, Nos. 2048-49, dated 27th May 1918, No. 406, dated 6th March 1919, and No. 1185, dated 17th June 1919.

25. *Temperance and Social Matters.*—Progress was made in assisting temperance movements among the fisher population. The Gnanodaya Samaj of Mangalore, a society which owes its origin and development to the devoted efforts of Mr. B. M. Thingalaya and which has branches in several villages, built an excellent hall—to which Government contributed—and this was opened in February last in the presence of several Fisheries officers. This hall is the first example of those desiderated for every fishing village of any size, to serve as school, as co-operative, temperance, and caste meeting room, as a hall for lectures and general social meetings, and recreation, and as a standing reminder of the need for progress. The influence of the meeting was considerable and has already borne fruit in several other villages, not merely in inciting persons to the cause of temperance, but in the beginning of arrangements (by the practical method of subscribing funds) for the building of similar, if smaller, halls for similar purposes. There is a distinct tendency towards a strong temperance movement on the West Coast, but on the East Coast there seem to be difficulties; the Assistant Director examined, for co-operative purposes, three hamlets near Cuddalore, but found a toddy shop in each where the fishermen only too readily spend the proceeds of their catches. I remember the same eleswhere. But with the hoped for advent of a strong movement fostered by the Fisheries Department towards schools and co-operation and it may be hoped, of men like Mr. Thingalaya and his friends, the cause should develop.

26. An interesting suggestion was made during the year by the Hon'ble Mr. Todhunter who inquired whether Fisheries could help the temperance movement by inducing or starting substitutes for the liquor shops. In many villages, probably in most on the West Coast, there are existing substitutes in the numerous tea-shops; moreover at Tanur, etc., peculiar non-alcoholic drinks of a spicy character are sold on the beach to the men, so many of whom are Mappillas and therefore teetotalers. This matter however is a very large one and has always been borne in mind; for years it has been suggested that the intended village halls will provide exactly the centres where many of the amenities of civilization such as music, lantern shows, etc., will be possible as mentioned in paragraph 25 above: these halls will take the place of liquor shops as places of friendly and social meetings as well as being places of business and education, and we may yet see, and not long hence, what has been discredited with a laugh, viz., the resort of humble fishermen not to the toddy shop but to their own recreation room or club.

27. *Oil and Guano Operations.*—These important matters progressed and retrogressed during the year. They progressed in the number of private

factories opened which reached the number of 358, and in the beginnings of co-operation applied to business (see paragraph 18 supra) but they retrogressed in that many factories were so badly and insanitarily conducted as to draw to them the adverse attention of the authorities; moreover some of the smaller factories deliberately added sand to the guano, thus tending to spoil the market. The Fisheries Department accordingly consulted with the authorities and a set of rules for the licensing, proper working, and due inspection of the factories is being drawn up for use during the current season.

28. On the whole the season was good in South Kanara and poor in Malabar, owing to the extreme smallness and leanness of the fish as mentioned s.v. Tanur supra.

29. Considerable business was done in buying fish-oil for the Munitions Board and guano for planters, etc., see paragraph 16 supra. Altogether 32,897 gallons of fish-oil were so bought for Rs. 15,865, besides which a quantity of very superior oil was made to meet a demand for such oil by the Munitions Factory at Dum Dum and the Harness Factory at Cawnpore. Under the guidance of this department twelve private factories began to make this high class oil for which double the ordinary price is obtainable and which is technically desirable.

30. *Fish-curing Yards.*—Under G.O. No. 752, dated 10th September 1917, six of the ordinary fish-curing yards under the Salt Department were taken over from 1st June 1919 in view to introduce gradually improved methods of curing, to be followed if successful, by assuming charge of other such yards: the experiment has only just begun.

31. Applications for opening new yards were received from seven villages distant from existing yards and were recommended for the sanction of the Board; three have already been sanctioned. Two of these new yards will be worked on co-operative principles as at Thalayi on a share capital of Rs. 1,500 in each case of which the bulk has already been paid: this is a totally new and very encouraging departure.

32. The result of the fishing with machwas (Ratnagiri pattern boats) was practically a failure, owing largely to a very unfavourable season for the working of such boats. The boat manned solely by a Ratnagiri crew only caught 5,580 lb. valued at Rs. 444, and that manned by a local crew only 4,093 lb. valued at Rs. 286. Fishing days were only 82 and 88 days respectively. The experiment requires recasting: the results are extremely short as compared with those recorded in my Cannanore reports; see Bulletin X, pages 12 and 32–33.

33. An interesting fact was the deputation of Mr. Christie, I.C.S., Commissioner of Tenasserim, by the Burma Government, to inspect fishery work in this and other Presidencies : it is hoped that his report will be very useful in developing the fishing industry in Burma. Portuguese officers from Goa also visited the West Coast works (Cannery and Tanur) and a Bombay officer was also deputed for similar purposes. Great developments should be in store for the West Coast fishery industries in the near future under new auspices.

ENCLOSURES.

Statement I.—Summary of expenditure and receipts of the Fishery Department, 1918–19.

Number.	Particulars.	Expenditure.			Receipts.			Difference.		
		RS.	A.	P.	RS.	A.	P.	RS.	A.	P.
I	Supervision and research.	56,302	5	1	273	6	0	— 56,028	15	1
II	Marine fisheries	73,196	15	7	1,47,919	1	10	+ 74,722	2	3
III	Inland fisheries	56,724	8	10	77,297	14	3	+ 20,573	5	5
IV	Factories	39,044	14	11	45,624	2	4	+ 6,579	3	5
IV-B	Vessels	8,398	1	8	6,030	8	6	— 2,367	9	2
V	Capital expenditure ...	1,451	14	10	...			— 1,451	14	10
	Total ...	2,35,118	12	11	2,77,145	0	11	+ 42,026	4	0

Statement III.—Profit and loss account of Chank and Bêche-de-mer fisheries for the season, 1918–19.

Expenditure.	Amount.			Receipts.	Amount.		
	RS.	A.	P.		RS.	A.	P.
Chank Fisheries—				Value of chanks fished—			
Tinnevelly	10,761	1	8	Tinnevelly	48,540	14	2
Rāmnād	29,701	0	2	Rāmnād	74,671	5	2
Sivaganga	242	1	0	Sivaganga	342	2	8
Ceylon	4,649	4	1	Ceylon	7,862	1	2
Bêche-de-mer fishery ..	950	4	9	Value of Bêche-de-mer fished.	1,550	7	5
Sixth year's proportion of the total consideration paid in 1913-14 for a fifteen years' lease of the Rāmnād Chank Fishery.	4,000	0	0	Chanks rentals received—			
				Tanjore district ...	4,100	0	0
				South Arcot district ...	1,886	8	7
				Chingleput and Nellore districts.	750	0	0
Supervision charges ...	6,789	1	11				
Balance being net profit.	82,610	9	7				
Total ...	1,39,703	7	2	Total ...	1,39,703	7	2

Statement II.—Details of receipts.

Marine fisheries.	RS.	A.	P.	Inland fisheries.	RS.	A.	P.	Factories.	RS.	A.	P.	Vessels.	RS.	A.	P.
(*a*) Receipts from all Chank Fisheries including Bêche-de-mer fisheries as per statement.	1,39,703	7	2	(*a*) Rentals from tanks, and rivers, etc., the fisheries of which were taken over by this department (vide statement VI).	76,262	9	4	(*a*) Cannery— (1) Actual receipts (amount remitted into treasury from sale of canned fish, etc.).	27,641	4	0	(*a*) Leverett ...	444	10	0
(*b*) Receipts from sale of Zoological specimens.	1,257	14	6	(*b*) Receipts from Sunkesula fish farm.	282	11	6	(2) Amount outstanding— RS. A. P. On 1st July 1919 ... 1,853 3 10 ,, 1918 1,854 2 7 Difference ...	— 0	14	9	(*b*) Turbinella.	...		
(*c*) Receipts from Pearl Farm.	63	6	10	(*c*) Receipts from Ippur farm.	89	10	0	(3) Value of manufactured goods on hand— RS. A. P. On 1st July 1919 ... 12,773 7 5 ,, 1918 ... 7,020 10 6 Difference ...	+ 5,752	12	11	(*c*) Canoes ...	4,854	15	1
(*d*) Receipts from Marine fish-farm, Tuticorin.	937	9	9	(*d*) Receipts by sale of larvicidal fish.	603	12	6	(*b*) Tanur— (1) Actual receipts	12,859	2	2	(*d*) Machwas.	730	15	5
(*e*) Receipts from oyster culture at Pulicat.	1,930	13	3	(*e*) Receipts from Gunpowder factory ponds.	25	6	7	(2) Amount outstanding— RS. A. P. On 1st July 1919 ... 1,677 8 4 ,, 1918 ... 1,724 3 5 Difference ...	— 46	11	1				
(*f*) Receipts from Marine Aquarium.	3,783	4	6	(*f*) Miscellaneous receipts	33	12	4	(3) Value of goods on hand— RS. A. P. On 1st July 1919 ... 303 8 8 ,, 1918 884 15 7 Difference ...	— 581	6	11				
(*g*) Miscellaneous receipts.	242	9	10												
Total ...	1,47,919	1	10	Total ...	77,297	14	3	Total ...	45,624	2	4	Total ...	6,030	8	6

Note.—In addition to above, other receipts were—

(1) Rs. 14,250, realized by the sale of engine of *Lady Nicholson* ;

(2) Rs. 100, sale-proceeds of anchor and chain belonging to 'Turbinella' ; and

(3) Rs. 273-6-0 (noted as receipt against 'supervision and research'), rent realized from the Fisheries Bungalow at Ennur.

Statement IV.—List of tanks and canals stocked by the Fisheries Department with the compensation paid and rentals realized for the year 1918–19.

Number and name.	Compensation paid.			Rentals realized.		
	RS.	A.	P.	RS.	A.	P.
1. Cauvery and Coleroon	34,898	0	0	58,323	13	0
2. Kurnool-Cuddapah canal	2,553	14	0	2,229	8	0
3. Belegal and Badaikhan tanks ...	16	0	0	175	0	0
4. Markapur tank	95	0	0	90	0	0
5. Venkatapuram tank	...			11	0	0
6. Kocheruvu	...			...		
7. Siddapuram	...			10	8	0
8. Kamalapuram tank	500	0	0	1,100	0	0
9. Daroji tank	155	0	0	555	0	0
10. Singanamalla tank	117	0	0	...		
11. Gudur and Karedu tanks ...	185	0	0	297	0	0
12. Ippur Kamini and Puduparti tanks.	5	0	0	58	12	0
13. Chembarambakkam and Maduran-takam tanks.	2,195	0	0	6,057	5	8
14. Dusi Mamandur and Kaveripakkam tanks.	3,789	0	0	6,511	10	8
15. Barur and three connected tanks ...	120	0	0	256	0	0
16. Penukontapuram tank	118	0	0	153	0	0
17. Rangasamudram	200 (17–20)	0	0	11	0	0
18. Tippasamudram				211	0	0
19. Tsadam				11	0	0
20. K. Vyasasamudram				201	0	0
21. Peddinayudu tank	...			...		
	44,946	14	0	76,262	9	4

Order—No. 1755, Revenue (Special), dated 15th September 1919.

Recorded.

2. The Department has been reorganized in the course of the year under review. Sir Frederick Nicholson, whose foresight and enthusiasm were mainly responsible for the initiation of the Department and its rapid progress through the early stage of development, handed over the office of Director to Mr. Hornell but continues in charge of the West Coast section. The post of Marine Biologist sanctioned in the reorganization remained vacant as it has hitherto been impossible to secure the services of a man of suitable qualifications and the requisite practical experience. Mr. J. H. Allan has been appointed to succeed Mr. Hornell in the immediate control of the marine operations at Tuticorin.

3. Among the important features in the year's work, the principal new developments were the transfer to the department of a number of fish-curing yards on the West Coast from the Salt and Abkāri Department to be run on model lines, the reorganization of the Aquarium the control over which was recently transferred to the Department of Fisheries and the initiation of a special scheme for the education of the fisher children and the training of their teachers.

4. *Marine Fisheries.*—In spite of unfavourable weather and difficulties in enlisting labour especially in Tinnevelly, receipts under this head show a substantial increase which was mainly due to the increased prices of the shells and especially to the high prices paid under the current contract for the Tinnevelly chanks. The net profit in the year amounted to Rs. 67,580, which is the highest yet on the record. The Government will be prepared to move the Government of India for the amendment of the Indian Fisheries Act in order to prevent the destruction of immature marine animals of economic value if the Director can convince the Government that legislative action would be effective and that the importance of the *bêche-de-mer* industry justifies such a course. The Government note with satisfaction the very useful work done in the matter of the supply of zoological specimens required by Indian colleges and universities and they are watching with interest Mr. Hornell's scheme for the reorganization of school museums in respect of collections illustrative of the fauna of the sea.

5. *Inland Fisheries.*—The Government attach considerable importance to the anti-malarial operations of the Fisheries Department and they hope that municipalities and other public bodies will in the course of time learn to recognize more generally the advantage of obtaining a good strain of larvicides from the department for introduction in malarial localities. The plans and estimates submitted by the Director for the conversion of the mosquito-infested moat around the Chingleput Fort into a fish farm are now under the scrutiny of the Chief Engineer to Government and orders will issue shortly. The proposals for the acquisition and stocking of tanks in the Chingleput and Nellore districts have been referred to the Collectors of the districts concerned. The Director is requested to expedite detailed plans and estimates in respect of the Vellore moat scheme.

With reference to paragraph 54 of the report, the Government doubt whether the increased rentals derived from the fisheries of waters recently taken under the control of the Department can safely be taken as a proof of the immediate effectiveness of stocking operations. There can be little doubt that the general increase in the prices of foodstuffs must have contributed considerably to the rise in the fishery rentals; and while the Government have little doubt that these operations will in time result in a large profit both to the local community and to the State, they do not anticipate that the advantages of scientific working will be fully felt for some years to come.

6. *West Coast Section.*—The Government note with satisfaction the progress made in the formation of co-operative societies for fishermen during the year, and in assisting temperance movements and other socio-economic work among the fisher population. The Director is requested to expedite the submission of the trading accounts of the cannery and other industrial branches of work in the West Coast Section.

(True extract)

(Signed) S. WADSWORTH,

Under Secretary to Government.

Report No. 2 (1920).

THE
OUTRIGGER CANOES OF INDONESIA

BY

JAMES HORNELL, F.L.S., F.R.A.I.,
Director of Fisheries.

Until now no adequate and connected account of the many varieties of the outrigger boats and canoes in use in Indonesia has been published; those of Polynesia and Micronesia are fairly well described, partly in the accounts left by old voyagers, partly in papers published by the United States Fish Commission, while those of Torres Straits have been minutely monographed by Prof. A. C. Haddon. A recent visit to the Dutch East Indies gave me opportunity to gather details of all the important types found in this region; the following is a summary of the peculiarities of the chief local variations evolved from the fundamental design.

Unlike the outriggers of Polynesia and of India and Ceylon, those of Indonesia are of the double type with few and unimportant exceptions. Their effective range extends from the north-western coast of New Guinea through the whole of the Moluccas and Celebes, thence north to the Philippines and south to Lombok, Bali, Madura and the eastern section of Java. Few are seen on the east coast of Borneo and none on the eastern shores of Sumatra. The western coast of Sumatra, and the islands east of Lombok (Sumbawa, Flores, Timor and Timorlaut) were not visited; there is no doubt, however, that double outriggers were formerly in general use in western Sumatra and still persist in rapidly decreasing numbers.

NEW GUINEA (N.-W. COAST AND SCHOUTEN ISLANDS).

The varieties in use in the extreme east, being the most primitive in design, I shall commence this detailed description with an

account of those found on the north-west coast of New Guinea and in the Schouten and other islands in Geelvink Bay.

The most important settlement in this region is Manokwari, the seat of the Dutch Government in these parts. Missionary effort is of long standing here, dating back to some time prior to Wallace's visit in 1858. Since then the local Papuan has learned to crop his frizzly mop of hair, and often sports an old jacket and dirty trousers ; the barbaric adornment of his person with bangles, ear-rings, and necklaces has largely been abandoned ; the big communal pile-dwellings of former days have given place to smaller ones on the Malay pattern ; his superstitions and animistic customs may be indulged in only in secret. The essentials of his life where they concern hunting and fishing methods remain, however, much as they were in the old days. This applies notably to his fishing boat design, and the implements of his craft. The canoe hulls are always dugouts, varying from a small two or three-man size used for inshore work to big craft of 30 feet in length. All the large sizes and most of the small are furnished with double outriggers ; a few of the latter for harbour use, have but a single one.

The largest sizes are fitted with numerous booms connected with the floats by means of upright stanchions. The number of booms varies greatly, being governed chiefly by the length of the hull ; at Manokwari the largest number noted was eight (Pl. II, fig. II), but at Serui an exceptionally large one with as many as eleven booms was seen.

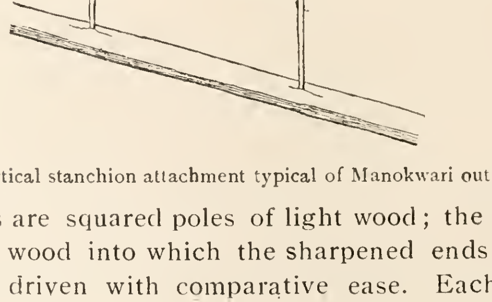


FIG. 1.—Vertical stanchion attachment typical of Manokwari outrigger canoes.

The booms are squared poles of light wood ; the floats are of a specially soft wood into which the sharpened ends of the stanchions can be driven with comparative ease. Each stanchion is

cut from a tough withy having a weak side branch towards one end. The main stem below the fork is cut a little longer than the distance at which the float is to be attached beneath the ends of the booms; a hole is bored near the end of the boom and the stanchion passed through till the thickening at the fork is reached. When all the booms and stanchions are in place the float is brought along and the sharpened points of the stanchions are driven into its upper surface. This done there remains only to bend down the side branch of each stanchion till it reaches the boom and to lash it thereto with rattan, in the manner seen in Fig. 1.

In the largest sizes two floats are employed on each side of the canoe; in this variety, a double row of stanchions becomes

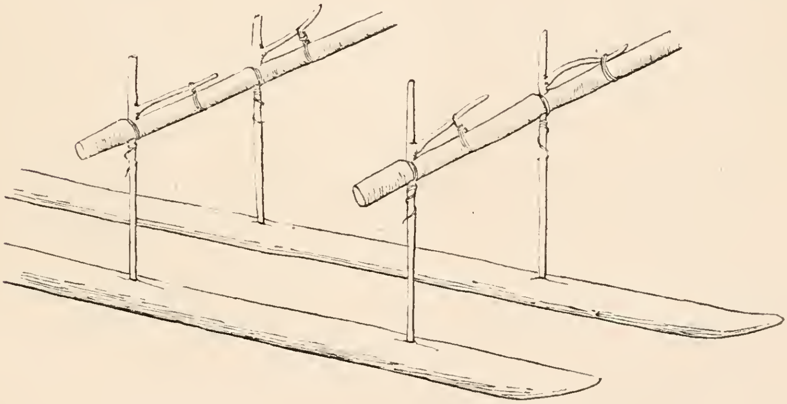


FIG. 2.—Double floats used in Manokwari outriggers of the largest size. The stanchions in these are lashed to the sides of the booms.

necessary (Fig. 2). The dugout hull of one such boat measured at Manokwari was 28 feet in length, 25 inches beam, with a depth of 26 inches. Seven booms crossed the hull and two floats were employed on each side. A cabin 10 feet long by about 7 feet wide is generally present in these larger fishing canoes, the greater part supported outboard upon some four of the transverse booms. A stiffening bamboo bracing pole is lashed lengthwise upon the booms half way between the cabin and the stanchions (Fig. 3),

and some have another along the row of stanchion forks, while occasionally in canoes with double floats, a rattan lashing connects

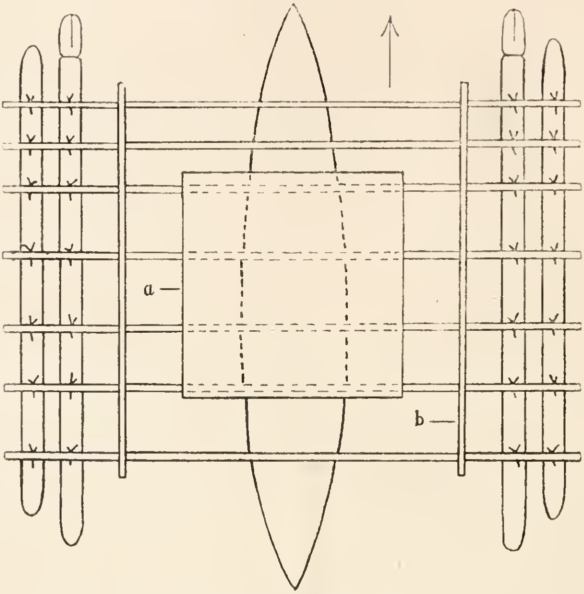


FIG. 3.—Plan of a large double Manokwari outrigger. *a*. platform occupied by cabin ; *b*. brace.

several of the stanchion pairs as shown in figure 4. At Manokwari the small canoes with three to six booms, are equipped with but

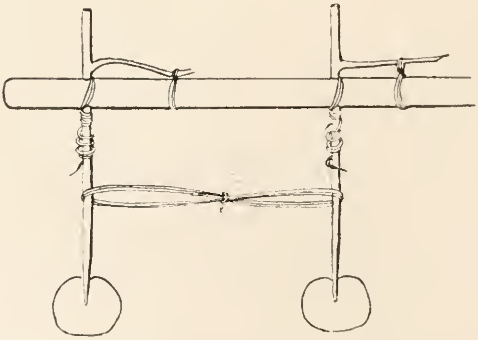


FIG 4.—Rattan lashing bracing each pair of stanchions, Manokwari.

one float on each side ; a few of the smallest are single outriggers with a float on one side only, usually the starboard. The end of

the float is often carved and sometimes is decorated with a design in black (Fig. 5).

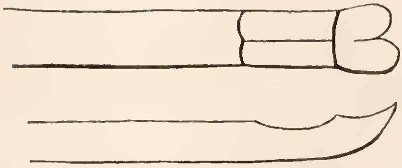


FIG. 5.—Carved anterior extremity of the boom of a Manokwari outrigger from above and also in side view.

The hull is an ordinary slabsided double-ended dugout. End pieces, ornamented with elaborate carving in the better built ones, are fitted on at each end, and between them the sides are raised with a weather-boarding made of several superposed rows of the leaf-stalks of the sago-palm, finished off with a squared wooden

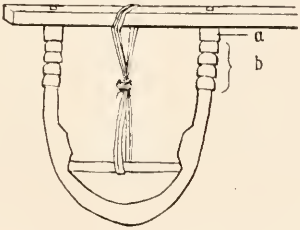


FIG. 6.—Section of the hull of a Manokwari outrigger, showing method of lashing the boom inboard; *a*. gunwale of soft wood; *b*. weather-board made of four palm leaf-stalks.

bar forming a rude gunwale; the whole structure is secured in position by vertical pegging (Fig. 6).

Considerable variation obtains in the design of the prow and

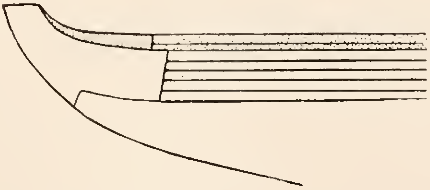


FIG. 7.—Fore end of a small Manokwari outrigger showing the form of added stem piece and the weather-board of palm leaf-stalks.

stern pieces. In small canoes these are simple in form, being carved out of the solid and added at each end to safeguard the

freeboard obtained by the provision of a weather-board of sago-palm leaf-stalks (Figs. 7, 8*a* and 8*b*, and Pl. III, fig. V).

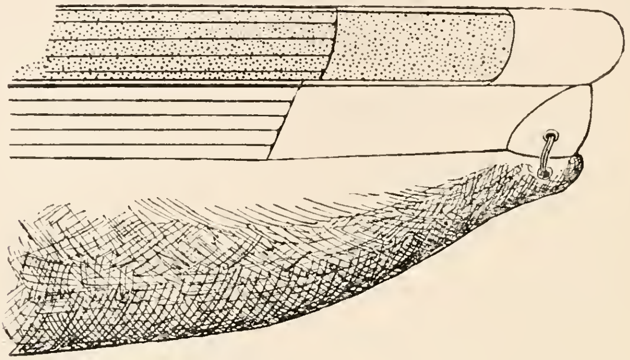


FIG. 8*a*.—Aft end of same dugout as shown in figure 7 showing added piece at stern.

In the larger canoes the prow has additional pieces added for the sake of ornament; two distinct patterns prevail, due possibly to the fact that Papuans from other villages in Geelvink Bay have migrated to Manokwari. Both are highly decorated, but one in use usually by canoes of medium size is much more complicated

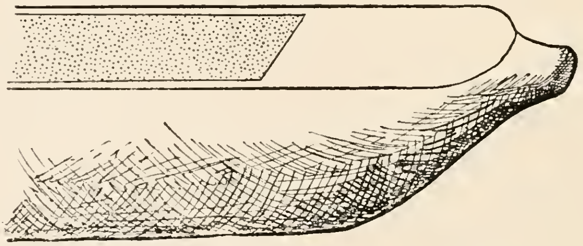


FIG. 8*b*.—The same before affixing the stern seat and the weather-boarding.

than the other. The latter is used by the largest fishing canoes provided with double floats on both sides; figure 9 shows better than words can describe the construction and ornamentation of this type. In these the stem piece is relatively longer and projects further than in the small unornamented canoes; at the fore end, fastened on by vertical pegs, is attached a high raised prow ornament carved from a plank, broad at the base, narrowing upwards to a terminal decorated point, pierced and carved in an

exuberant scroll design (Pl. II, fig. III). Just beneath the point is usually a hexagonally grooved pumpkin-shaped oblong knob. The perforated scroll work is painted alternately black and red;

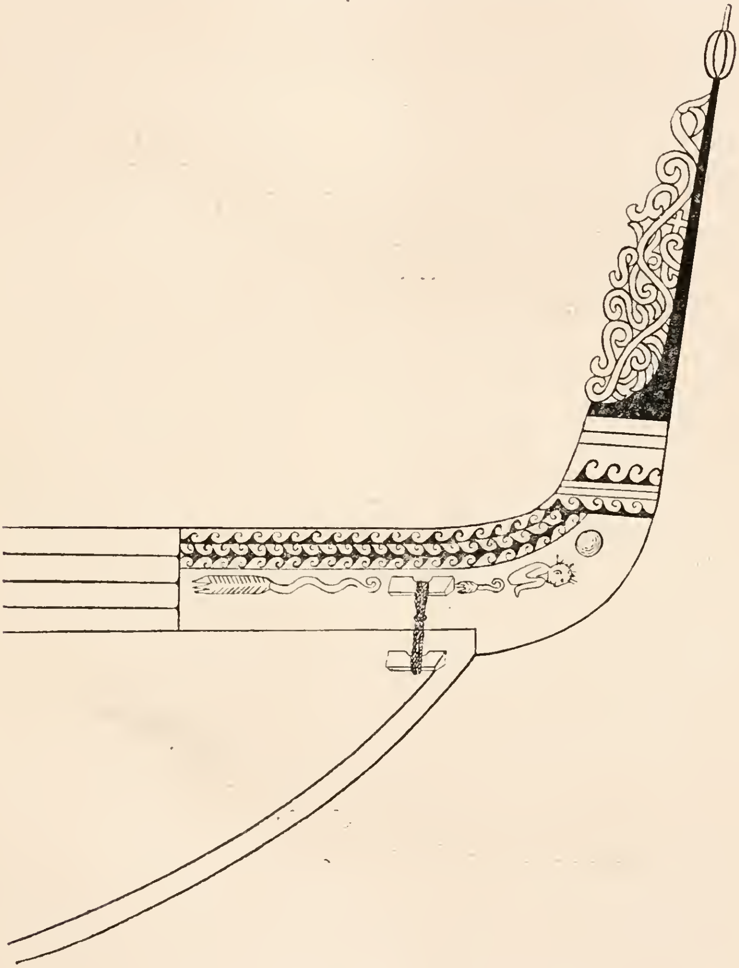


FIG. 9.—Decorated prow of a large Manokwari outrigger.

below this, the solid base has black, red, and white bands above, with a band of wave pattern below. The stem piece upon which this high pierced prow is fitted is carved from the solid, and fitted upon the fore end of the canoe partly by means of pegs, and partly by a lashing on each side passed through holes cut in projecting cleats left when shaping these parts.

The ornament on the side of the bow piece consists of relief carving along the centre, margined above in the most elaborate example by a painted frieze of three rows of a conventional wave pattern worked in three colours. The carved median figures represent, taken in order from before backwards, *a.* a mamma-like boss, *b.* a human figure crouching on his haunches with stiff tufts of hair formed by wedging small bunches of palm fibre into small holes punched over the head, *c.* a tiny snake heading forwards, and *d.* a much larger representation of another snake with head apparently trifid, directed aft; the size of the head region is much exaggerated and displays a distinct herring-bone pattern along its whole extent. A somewhat similar stern ornament is fitted on special occasions.

The second style of ornamental prow seen at Manokwari is even more numerous at Wooi Bay, Serui, Bosnik and Pom, all settlements in Jappen and the adjacent islands in Geelvink Bay.

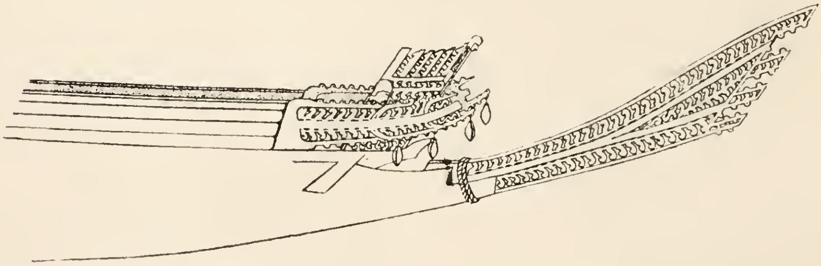


FIG. 10.—Decorated prow of a large outrigger, Wooi Bay, showing egg cowries pendant from the horns of the pierced bow-pieces.

Figure IV on plate III exhibits the chief peculiarities of this design and its differences from the one previously described. In this, which appears less primitive than the other, the fore end of the dugout is fined down and considerably elongated in a horizontal direction to give purchase for the attachment by splicing and lashing of a graceful wing-like curved prow ornament. Instead of being perpendicular as in the companion design, this continues forwards and upwards the under curve of the canoe's bow. It is cut from a thin plank, the fore edge nicked into several narrow teeth and the body frequently pierced in a fretwork of short scrolls arranged in parallel bands. Behind this is the true bow piece connecting with and finishing off the weather-board fitting on either side. Unlike the corresponding parts in the other canoes it is made

up of separate pieces forming a box-like structure, open behind. It consists of two sides each with a forwardly directed horn-shaped projection from the upper edge, a transverse bulkhead at the front between these sides and a high rudder-like ornamental part fitted edgewise against and in front of the bulkhead. This last part together with the two sides are usually pierced with fretwork scrolls (wave-pattern ?) after the manner of the prow piece. The mode of attachment of the median piece accentuates its likeness to a rudder, for the hinder edge is furnished with a pintle-like peg to fit over the top edge of the athwart bulkhead ; the head of the pintle is fashioned to represent the Papuan conventional human face, and another but smaller head is found at the upper outer corner. No further decoration is usually present in Manokwari canoes of this type, but at Wooi Bay and other of the Papuan villages in the islands in Geelvink Bay, what no doubt represents the formerly universal fashion in this district still prevails ; in these the projecting wing-like horn of each side is decorated with the porcelain-white shells of the egg-cowry (*Ovum ovum*), suspended from the fore end and from projections on the under edge ; usually a single shell is hung from each point, sometimes a bunch of two or even of three may be thus suspended. In a fully decorated canoe, a row of three shells is generally hung from each side projection (Fig. 10). It is probable that in former days and even now during festivals this shell was and is employed more lavishly in decoration, for in one instance I saw each of the heads of the outrigger stanchions ornamented with a shell, tied on, together with a bunch of leaves.*

In the recess in the bows provided by this ornamental structure is stowed the shallow basket holding the turtle harpoon line. In passing, it is worthy of note that the line is fitted with wooden disc 'retarders', sometimes highly ornamented with carving. In some cases they are fashioned into somewhat conventionalized representations of fishes (Fig. 11), birds, and fish-tails (Fig. 12); others, the less important ones, have incised geometrical patterns on one side (Fig. 13).

In all the sailing canoes in this district which adhere to the original style of rig, a tripod mast and oblong sail are carried.

* Considerable petty trade is carried on by Chinese traders in these shells on the New Guinea coast, the chief demand appearing to be from further east ; the Solomon islanders are noted for their love of the egg-cowry in their decorative schemes.

This mast, which we shall see is more or less prevalent throughout the eastern section of the Malay Archipelago—particularly

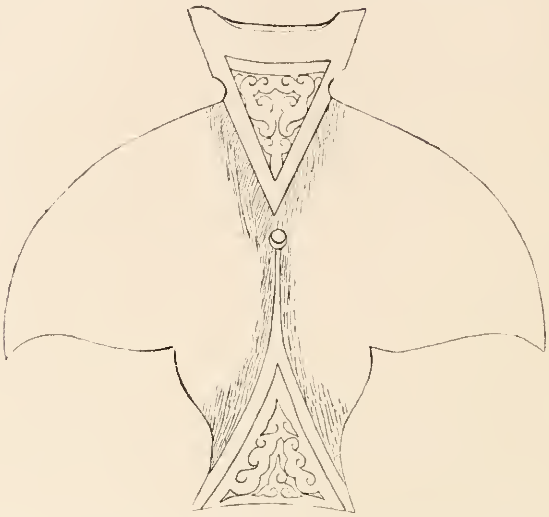


FIG. 11.—Line retarder on a harpoon line ; it is a conventionalized representation of the great Ox-rays (*Dicerobatis* spp.)

in the Moluccas and Celebes—is here composed of three bamboos, connected at the apex by rattan or rope lashing. The smaller New Guinea canoes have usually a Y-shaped crutch peg fitting into the top end of one of the paired legs; upon this is hitched a

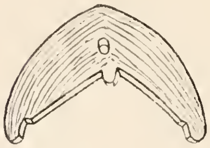


FIG. 12.

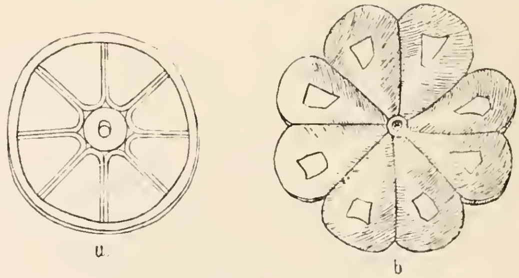


FIG. 13.

FIG. 12.—Another line retarder in the form of a fish tail.

FIG. 13.—Two other retarders of geometrical design. In *b*, pieces of mother of pearl are inlaid as decoration.

loop attached to the yard of the sail at a point a little way forward of the centre. In larger canoes where the increased size of the sail renders it impossible for the crew to lift it high enough to

hitch the loop over the mast-head peg, a hole is cut in the projecting end of one of the paired mast legs which is cut longer at the top than the other; through this hole a rope is rove and by this means the sail is hoisted. The sail is oblong with a bamboo yard along the upper edge, and a similar pole along the lower. This is the same style of sail seen in the Buddhist sculptures in the Boro Budur ruins in Central Java, a building dating from the eighth and ninth centuries of our era (Frontispiece).*

In Wooi Bay in Jappen Island, the canoes seen were all of the single outrigger form, rare at Manokwari; the structure of the outrigger parts, the form and ornamentation of the bow and the rig are otherwise as already described. The number of outrigger booms varied from three to seven. Decoration of the canoes with the shells of the egg-cowry is more prevalent than at any of the other villages visited except Serui; several men wore one of these shells suspended from a bead necklace around the neck. In other cases the suspended amulet was a cylinder of wood carved at the attached end into the semblance of a squatting human figure with a much elongated nose, the tip turned down over the upper lip in the characteristic Papuan convention. It is noteworthy that the noses of the people here are not typically of this form, the majority being heavy and of the bottlenose shape which attracted Dampier's attention when he was cruising among these islands. It may also be remarked here that the cylindrical form of the wooden neck amulets hung from one end, is a common form among the ornaments strung on necklaces among the lower castes in South India. This parallelism is perhaps significant, for such a shape of necklace ornament is not widely spread elsewhere so far as I am aware.

At Serui the canoes are almost identical in construction and decoration with those at Wooi Bay except that the largest sizes, running to a length of 30 feet, have double outriggers with as many as eleven booms in some. Such large ones sometimes have two floats on each side, with a corresponding increase in the number of stanchions. The small and medium sizes are all single outriggers, and in these the float is boomed out on the starboard side.

* Mat sails are generally used, but at Manokwari where the fisher people come into contact with people from the Moluccas, the greater advantage of a cotton sail has been realized by some and a few have even gone so far as to adopt either the spirit or the lug as their sail pattern

The canoes at Bosnik in the Schouten Islands are similar to those of Serui, both single and double outriggers being in use, with the same variations in details.

Pom, a group of very populous and purely Papuan villages on the north coast of Jappen Island, employs canoes of like design. In one only did I see any divergence; here instead of a pierced median plank at the force side of the bow bulkhead, the owner had placed a rounded or head-shaped ornament covered with tufts of black fibres let into holes punched over the whole surface to give the appearance of a human head. Mr. Van Hasselt, a Manokwari missionary, informed me that its employment is to obtain protection for the canoe against evil spirits. Probably the pendant egg-cowries are for the same purpose; as the canoe breasts the waves, particularly in rough weather, the shells clash together, emitting a tinkling sound and, as we know, various noises, such as the blowing of conchs, are commonly supposed to have effect in scaring or appeasing harmful spirits.

East of Geelvink Bay, beyond Cape D'Urville, except for an occasional visitor from the Schouten Islands, no double outriggers are seen, neither does the use of multiple booms and vertical stanchions extend beyond this point.

WAIGOU AND THE N.-W. POINT OF NEW GUINEA.

At Saonek, the chief port in the island of Waigou, and at Sorong at the extreme north-west point of New Guinea, intercourse with the Moluccas is of extremely long standing. These places were gateways to New Guinea even before the coming of Europeans to those waters; in consequence the population is far more mixed than further east, and this is the explanation of the fact that the type of double outrigger in use here is wholly different from the Geelvink Bay type; affinity on the contrary is with the boats of the Moluccas. They have however distinctive points, the most noteworthy being that the majority have four booms, as against the two normal to the Moluccan outriggers; a few only have the number reduced to three.

The Waigou type, as we may term these outriggers, are well built and much more carefully put together than the majority of the Geelvink Bay canoes (Pl. IV, fig. VI). The hull is built up upon a dugout with flared sides, deep wash-strakes being added to the requisite height. Four or five booms cross the canoe; each is

connected with a float on either side by a long elbow-shaped joint having normally as hort inner limb and a much longer outer one. The latter is inclined at about 110° from the short limb, and passes so obliquely downwards that the float lies considerably beyond the

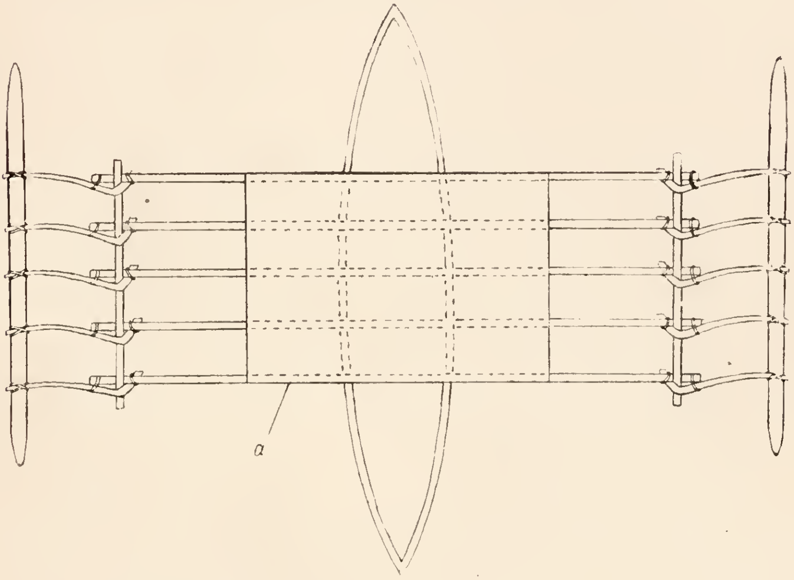
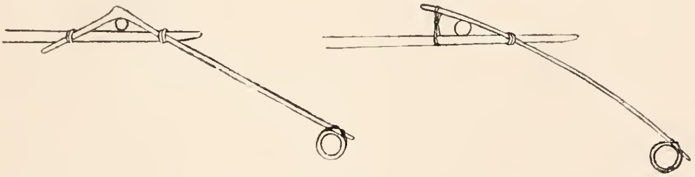


FIG. 14.—Plan of a Waigou outrigger. *a*. cabin platform.

extremities of the booms (Fig. 14). The upper end owing to the elbow or angle present there, can be secured to the boom very strongly by two lashings, and further stiffness is obtained by the insertion of a longitudinal bracing pole between the angle of the



FIGS. 15 AND 16.—Two forms of the connecting secondary Waigou type.

elbow and the boom (Fig. 15). The long limb is straight or only slightly curved; its distal end is lashed upon the upper surface of the boom. In some examples the short limb has disappeared and the joint reduced to a single nearly straight rod (Fig. 16).

In the larger canoes a fairly roomy cabin is provided; this is of great use to the crew both when engaged in fishing or when away on prolonged trading trips. The double outrigger frame permits of a fairly large structure as the booms enable it to be built outboard on each side to a distance of a couple of feet. Part of the outboard cabin space is utilized for a sand-box fireplace, so the crew and their passengers enjoy a fair amount of comfort. Water is carried in long bamboo joints set upright in the cabin.

The outrigger design is particularly useful when cabin accommodation is necessary to fishermen who cannot afford large plank-built boats, for the employment of this device permits the owner to use a comparatively small and inexpensive hull to what would otherwise be necessary. This is the real *raison d'etre* of the continuance of the double outrigger design in waters where the superior handiness of the boat type must be well known.

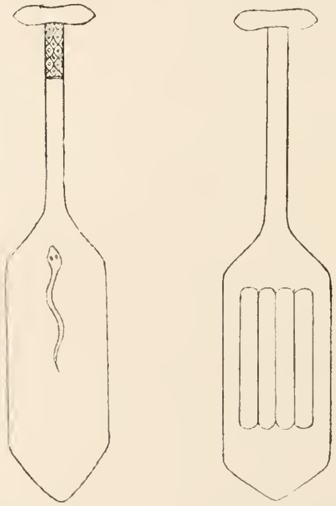


FIG 17. FIG. 18.
Two carved paddles, Waigou.

Tripod masts and mat sails are the usual rig, but cotton sails are gradually becoming more frequent. The paddles used are of heavy ironwood and in a few cases most beautifully ornamented with carving. In the finest one seen at Sorong the upper end of the shaft was elaborately carved, while the blade bore a finely worked representation of a snake, the body disposed in elegant curves, the eyes picked out in ivory (Fig. 17). In another case the carving on the blade was a very chaste line pattern, the lines

cut in low relief (Fig. 18). The simplicity and good taste of both designs were remarkable, the effect enhanced by the absence of superfluous accessory ornament.

THE MOLUCCAS.

Throughout the Moluccas all outriggers are of the double type; with the exception of a few large ones seen at Weda, in the south-east of Halmaheira, two booms only are employed. Two main types are present, one with elbow-shaped secondaries connecting the booms with the floats, the other having the connexion made by means of withy loops.

The former, termed by Haddon, the Halmaheran, may more appropriately be called the Eastern Indonesian type as it is found in one variation or another throughout the eastern part of the Malay Archipelago, from the eastern coast of Borneo to the coast of New Guinea, from the north end of Celebes to Lombok in the south. The second in its chief varieties I propose to call the Amboyna and Buru types respectively as they are there the common forms.

HALMAHEIRA AND ITS DEPENDENT ISLANDS.

The Eastern Indonesian type.—At no port in Halmaheira is this type of outrigger wanting, but considerable variation in the details and ornamentation is seen. The essential features consist of the restriction of the booms to two in number (at Weda three are occasionally employed) and the attachment of the floats to the booms by means of elbow-shaped joints or brackets. The dimensions vary greatly, from small dugouts to built-up planked boats. The largest sizes, of three varieties, are found chiefly on the east coast of Halmaheira, hailing from the ports of Galela, Tobelo, Kao, Buli and Weda; the small sizes are universal.

The three large varieties may be called respectively the Galela, the Buli and the Weda varieties from the places which are the chief centres of their occurrence.

(a) The Galela outriggers are often met far from their home ports; their owners are petty traders as well as fishermen and in the season carry cargoes of home-grown tobacco for sale throughout the islands of the group, particularly to Ternate and Batjan. Their craft are true boats, planked up, with a keel, ribs and a fairly roomy cabin. A bamboo forms the float on each side. The connecting elbow-shaped joints differ considerably from the Waigou

form. In the present one the short upper limb of the joint is straight and not curved downwards (inwards); it is lashed so that it lies nearly parallel with the boom, above which it is raised by the thickness of a brace pole lying in the bend of the joint. The joint is lashed at two places to the boom, as shown in figure 28. The long limb is slightly curved outwards and secured to the upper surface of the float by a lashing. A second brace-pole laid across the ends of the booms on the outer side of the joint angle is secured parallel to the inner brace. These are connected with the bamboo float by three long lashings. The whole complicated fitting is well designed to meet the various stresses to which the outrigger frame is exposed.

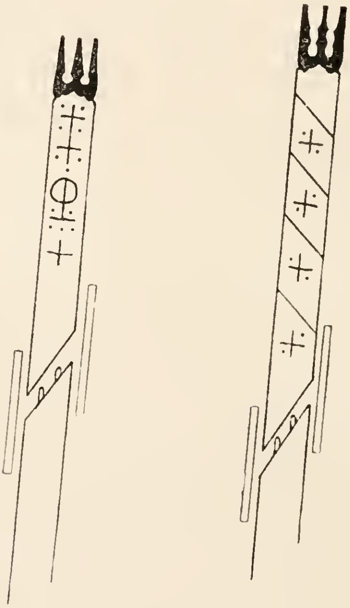


FIG. 19.—Ornamented stem pieces of two Galela outriggers. (The splice connecting each piece with the stemhead is shown open to exhibit the method of attachment.)

A paddle is usually used in steering, but in the largest boats a quarter rudder suspended by a grommet from a steering crutch, is sometimes employed. A characteristic feature whereby the Galela outriggers are readily recognized is the curious upstanding ornament carried at stem and stern. This is fashioned from a long and narrow plank notched at the upper end in trifid fashion. This terminal part is generally coloured black, while the flat sides are

decorated with crude figures made up of crosses, circles and dots, painted in black upon the naked surface of the wood. Two typical patterns are illustrated (Fig. 19). Others were different and no two are exactly of the same pattern. In many boats the outer edge of the gunwale is carved. The hull of one measured at Ternate was 24 feet long, with a beam amidships of 5 feet and depth of 25 inches; the keel was $3\frac{1}{2}$ inches deep, running the whole length. Three others measured at Galela were respectively 20, 20 and 22 feet long. In the Ternate example there were 7 strakes on each side of the keel; each strake had a row of projecting perforated 'lugs' left in the centre at 5 intervals and those of each strake were spaced so as to coincide vertically with

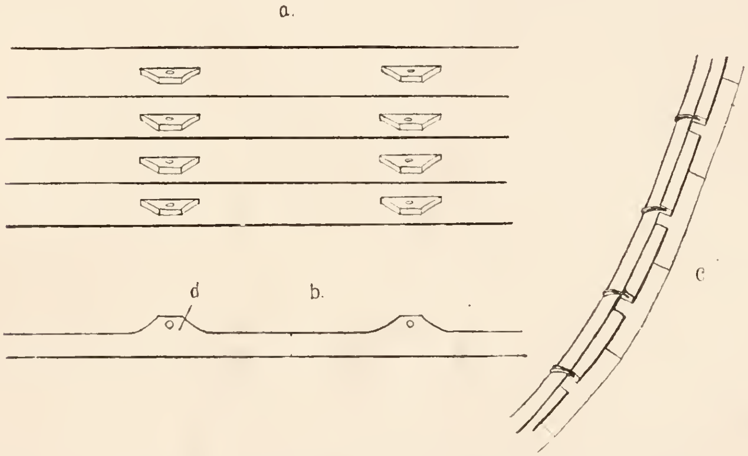


FIG. 20.—Details of the hull construction in Galela outrigger boats. *a.* inner view of four planks with two vertical rows of projecting cleats or 'lugs'; *b.* longitudinal section through a plank and two cleats; *c.* Vertical section through four planks to show how a rib is lashed to the cleats.

those above and below (Fig. 20). In building, the planks are first secured together with vertical pegs; afterwards when the hull is complete, frames or ribs are fitted *over* the vertical rows of projecting cleats, and tied thereto by cord made from black palm-fibre. Thus the ribs do not lie against the inner surface of the planking, but are separated therefrom by the thickness of the cleats to which they are tied. By this device no metal fastenings are required; such a hull possesses great elasticity and stands bumping in the surf in a way that no metal-fastened boat would long survive.

The beamy design of these boats permits of the cabin being built up from the gunwales; unlike the Waigou type the cabin is

not built partly outboard, upon the outrigger booms. In the present design strong thwarts projecting a few inches outboard are substituted. By the utilization of the interior of the wide hull as part of the cabin, the height of the cabin roof can be kept lower than in the Waigou boats. A light bamboo framework as shown in figure 21, affords stowage room for various tackle above the cabin roof, thereby liberating useful space within.

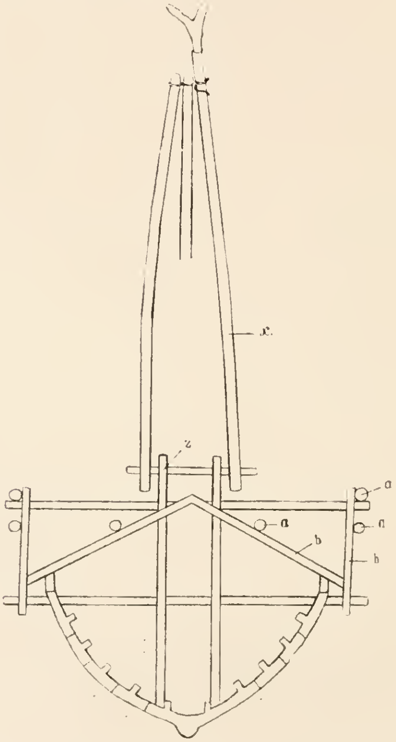


FIG. 21.—Diagrammatic section through a Galela boat, to show the relationship of the paired legs (*x*) of the tripod mast with the tabernacle (*z*) and the framework of the cabin. *a*. Section of poles laid fore and aft to stiffen the cabin framework.

The ordinary rig is the tripod bamboo mast used in conjunction with an oblong sail; the same rig as the Waigou outriggers above described. Most of these boats now use cotton sails, but the older mat sail is still to be seen fairly commonly, especially among the smaller outriggers.

To carry the paired legs of the tripod mast, a simple tabernacle is provided on the roof of the cabin at the fore end (Fig. 21) The twin legs are short and about the length of the cabin. The

unpaired leg is longer and is stepped half way between the cabin and the prow. The details of this tabernacle in reference to the other parts of the cabin framework will be seen by reference to figure 21. In the better class of these boats, this tabernacle affords considerable scope for the strong artistic feeling displayed by the people of Galela. Figure 22 depicts one of the most elaborately

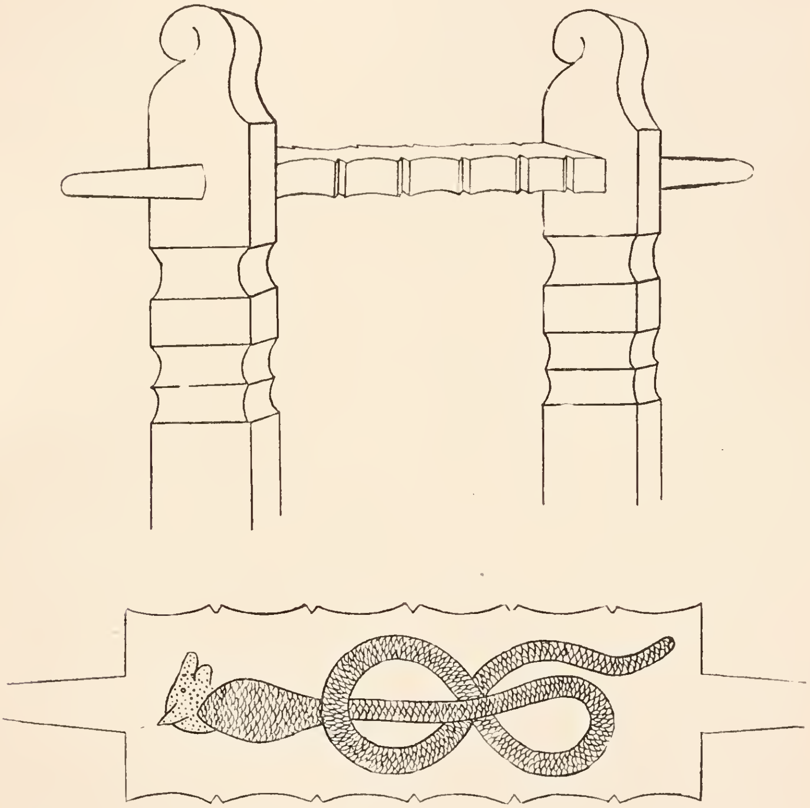


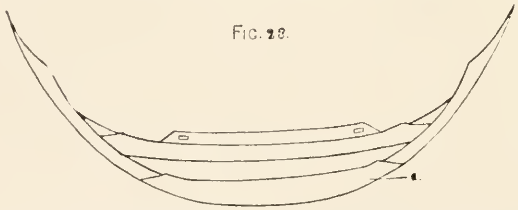
FIG. 22.—Tabernacle of a Galela boat and carved upper surface of the cross-bar.

carved of these mast supports. The cross-bar in this was most carefully carved in high relief, the motif, a coiled snake swallowing a dog or some other small animal. The uprights were actually more elaborately carved than is depicted, as time did not permit all the detail to be copied.

To carry the yard of the sail at the mast head, a Y-shaped peg is inserted into the top end of one of the paired legs. This one is left a few inches longer at the top than its partner (Fig. 21). In

hoisting sail the tripod is first erected, the two paired legs being each provided with a slot near the foot, which is slipped over the laterally projecting end of the cross-bar of the tabernacle. The unpaired leg has similarly a perforation in the foot, but here it runs fore and aft. This slips over a projecting peg on the foreside of a thwart half way between the tabernacle and the stem. Properly adjusted such a tripod is quite stiff and requires no stays. When the mast is up, a loop placed near the mid-length of the upper yard of the sail is slipped over one arm of the Y-peg at the mast head, a boatman holding up vertically the rolled up sail till he manages to hitch the loop over the peg. The sail is then unrolled and the sheet made fast astern. The fore end of the boom is secured to the same thwart to which the unpaired mast leg is attached or else to one right at the stem. In heavy weather the lower edge of the sail is partially rolled up around the boom and the yard lashed half way or so up the mast.

(b) The East Halmaheira or Buli variety of plank-built outrigger, hails chiefly from the ports of Tobelo, Kao, and Buli on the eastern coast of Halmaheira. Usually the planked hulls are built up upon a very narrow dugout base which serves the purpose of a keel;



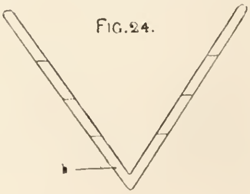


FIG. 23.—Diagram of the side view of Kao outrigger boat. FIG. 24.—Vertical section amidship of same on a larger scale. *a.* and *b.* The dugout hull forming the keel portion in each.

indeed at Kao the direct evolution of this design from the ordinary small outrigger dugout is clearly exhibited in the perfect gradation of all stages, from the plain dugout without any added pieces through a stage where a single wash-strake is added together with prominent stem and stern pieces, up to large boats built up of 3 and 4 or more strakes, and possessing a fairly roomy cabin. Some have a nearly straight keel, but many of the medium-sized Kao ones have the dugout keel portion strongly curved, with stem and stern posts continued upwards with inordinate sheer as shown in figure 23. One such boat measured on the Buli beach was 20 feet long overall, 4½ feet wide amidships, and 3¼ feet deep. This

boat had 3 broad strakes pegged on; in many the sides rise so steeply from the dugout keel as to give the boat a V-shaped transverse section (Fig. 24); others have a flatter section particularly those of large size as otherwise the draft would become too great. The larger boats have cabins much after the style of the Galela boats; from these they are readily distinguished by the shape of the stem and stern post projections; instead of having pegged-on straight pieces, the projections are continuations of the stem and stern posts, rising to four and even five feet beyond the gunwale;

Fig. 25. Stem and stern forms in two Kao outriggers.

the upper end of each is brought to a sharp point by a long slightly concave cut which leaves a characteristic angular prominence two-thirds up the inner edge of the post (Fig. 25). The length of the terminal pieces appears to vary with the fancy of the owner.

The outrigger frame scarcely differs from that of the Galela boats except that in some places the connecting joint shows a

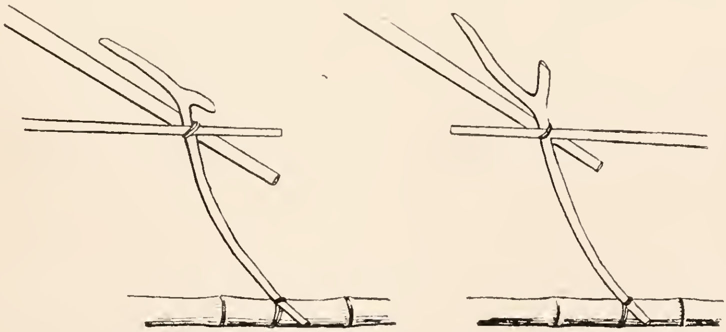


Fig. 26.—Two forms of boom and float connexions seen in Kao. (Inner stringer has been omitted.)

characteristic heel on the outside of the joint angle (Fig. 26), and two brace poles are employ ed, one within and the other without the

joint angles. The two booms pass through slots in the topmost strake.

(c) The Weda design.—At Weda, further south, the large outriggers are not plank-built; the hulls are large dugouts, running to 25 feet in length. Some have the depth increased by the addition of a wash-strake where the dugout has not sufficient freeboard. Two examples measured were respectively 25 feet overall, 2½ feet beam and the same in depth, and 24 feet by 2 feet 7 inches wide by 2½ feet deep; the latter had a wash-strake added. These boats carry a cabin of the usual style, the sides built outboard upon the support of the booms. The bow and stern pieces are short and inconspicuous.

The outrigger design departs from that seen elsewhere in the Moluccas in being provided with three transverse booms; usually all three are attached to the floats by heeled elbow joints after the Buli pattern; in a few the middle one is sometimes omitted. Two strengthening brace poles are used as in the other designs described. A further peculiarity is the frequent use of a bamboo and a jungle pole lashed together to form a compound float. Where the float is single, a tree pole is employed. In the use of more than two booms, this design approaches that seen on the opposite coast of New Guinea, hence the Weda boats form the connecting link between the Moluccas and New Guinea. This is to be expected; for the east coast of the Moluccas faces New Guinea and the population of so-called Alfuros show distinct hybrid characteristics wherein a Papuasian element is marked. Strangely enough there is little or no trace of frizzly hair to be seen; from various facts which have come to my notice, I am led to infer that the frizzy mop of the Papuasian is of a recessive nature liable to be eliminated when crossed with the straight-haired races.

Batjan Island.—At Labuha in this island, which lies to the west of the southern extremity of Halmaheira, the finest and largest example of Moluccan outrigger boats was seen. It was a big boat about 30 feet overall, beamy but of little draft (Fig. 27). The ends rose high and sharp, gradually narrowing till they became attenuated to a sharp point, in this closely resembling the big gondola-like boats without outriggers seen everywhere in Halmaheira ports. Unlike the latter, the Batjan boat had no pumpkin-shaped ornament on either of the high projections; two booms only were employed, but the float was more strongly constructed than

in any other Moluccan outrigger; it consisted of three stout bamboos lashed together, two under the outer end of the connecting

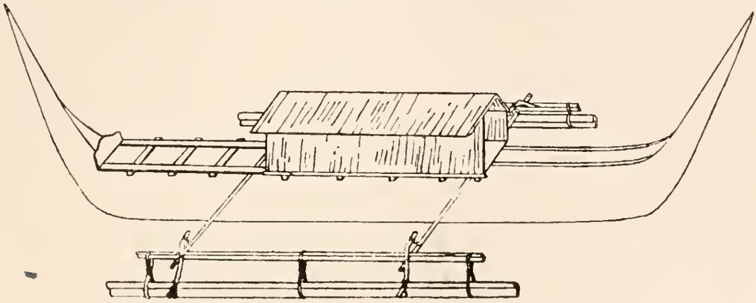


FIG. 27.—Larger outrigger boat, Labuha, Batjan Island.

bracket joint, the third above it (Fig. 28). Otherwise the outrigger frame was as in the Galela boats.

The hull, built up of numerous strakes pegged together and furnished with perforated cleats on the inner side for the attachment of ribs, was crossed by numerous thwarts, with ends projecting beyond the gunwale. Upon this basis was erected a large cabin situated amidships in the space between the outrigger booms, the

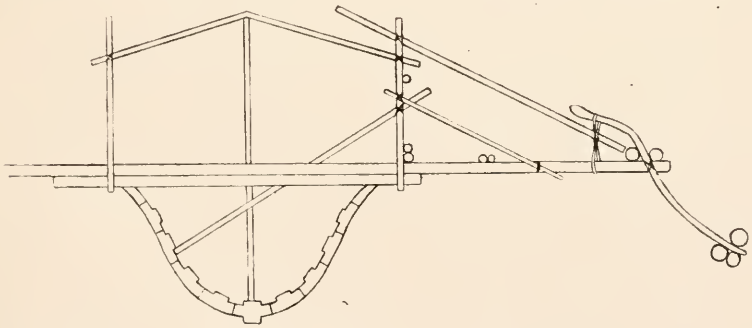


FIG. 28.—Dagrammatic section through the boat depicted in figure 27, to show cabin framework and outrigger construction, Batjan Island.

roof covered with atap leaves. The framework was ingeniously constructed in somewhat different manner from that already described. The details are shown in figure 28.

At one end beyond the cabin the outboard ends of the projecting thwarts were made use of to provide a narrow outboard platform.

Outrigger dugouts.—As already mentioned the smaller dugout outrigger canoes of Halmaheira and the adjacent islands are of two types, the one having angular secondaries of the Eastern

Indonesian type, the other with the connecting joint formed from a bent withy—the Būrū or U-type. The former require no lengthy description—the hull is a simple unornamented dugout with outrigger frame exactly as in the ordinary Galela boats. They run from 8 or 10 feet long to double this length. In Tobelo they are termed *prau sema sema*, in Buli, *pelang aio ; sema sema* meaning 'outrigger', *aio*, being 'tree' in the local Alfuro dialects. I may mention here that the large cabin outrigger boats with high stem and stern fittings, are called *prau păketà* at Tobelo and *pelang păk-păk* at Buli.

In the Būrū design, two outrigger booms are employed as usual, but instead of an oblique bracket connexion whereby the float is maintained at a little distance beyond the ends of the booms, the connexion is made by a withy bent into the shape of the letter U ; the upper ends are lashed to one side of a boom near the extremity, the base being bound to the upper surface of the bamboo float (Fig. 29).

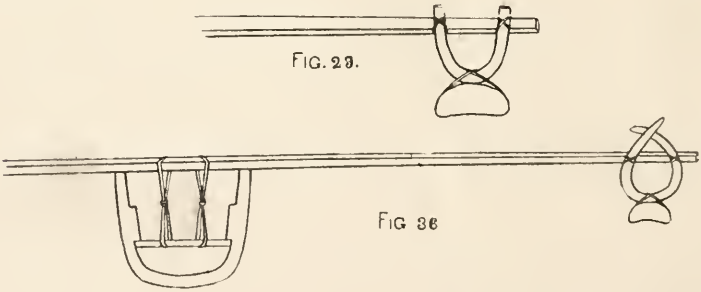


FIG. 29.—U-attachment used to connect boom and float in Būrū outrigger.
FIG. 36.—Loop attachment characteristic of Amboina. The figure also shows the method of securing the booms within the dugout hull.

This is a pattern that appears to have come to Halmaheira from the south, through Būrū and the Obi Islands where it is the prevailing type of outrigger used in connexion with dugout canoes.

The distribution of the two forms of small dugouts through Halmaheira is significant. At Labuha in Batjan, the great majority of dugouts are of the U-design, a few only being of the East Indonesian type ; at Tidore, Ternate and Djailolo, the majority of the inshore and harbour outriggers are again of the U-type, but a larger proportion than at Batjan have elbow joint secondaries. Generally the slabsided dugouts have the former, those that have flared sides the latter ; these are also generally the larger. All

these are on or off the west coast of Halmaheira. Round the north end of the island, we find that at Wajabula in Morotai Island, the proportion is reversed. Here the majority are of the East Indonesian type, only one-third the total having the U-form of secondaries. In the former, two brace-poles are used to stiffen the outrigger frame in the way already described. The outer one is the longer and is tied to the float in the manner shown in figure 30. The float in the smaller canoes consists of one, or more commonly

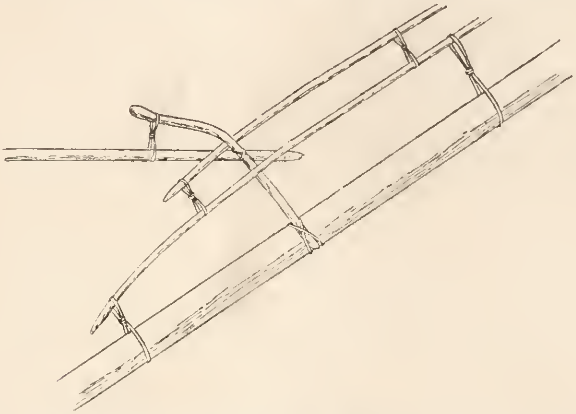


FIG. 30.—Method of stiffening the outrigger frame by braces in use at Wajabula, Morotai Island.

of two slender bamboos; sometimes a pole is used; in such cases the forward end curves up slightly and is carved on the under side in the same fashion as is seen occasionally (rarely) at Batjan and the Obi Islands (Fig. 31). South of Morotai Island, the U-design disappears on the east coast of Halmaheira; none was seen at Galela, Tobelo, Kao, Buli, Patani and Weda, where the East-Indonesian type of outrigger canoes is employed exclusively. The U-type pertains to the western side of Halmaheira and to the islands to the south, lying between that island and Amboina.

THE OBI ISLANDS.

Here the Būrū type of U-shaped secondary is adopted almost entirely for small dugout canoes working inshore. Sometimes the float is double, made from two leaf-stalks of the sago palm tied together. A single small canoe was seen having the elbow-shaped secondary with the outer or long limb nearly vertical, so that the float was immediately under the angle of the elbow.

Larger craft with flared wash-strakes upon a flared dugout basis, had secondaries of the usual oblique Eastern Indonesian

type. One used as a passenger boat had a large square well in the centre, built partly outboard, with seats along the side. The inner and upper arm of the secondary was attached particularly high above the boom with two brace poles both placed *within* the elbow

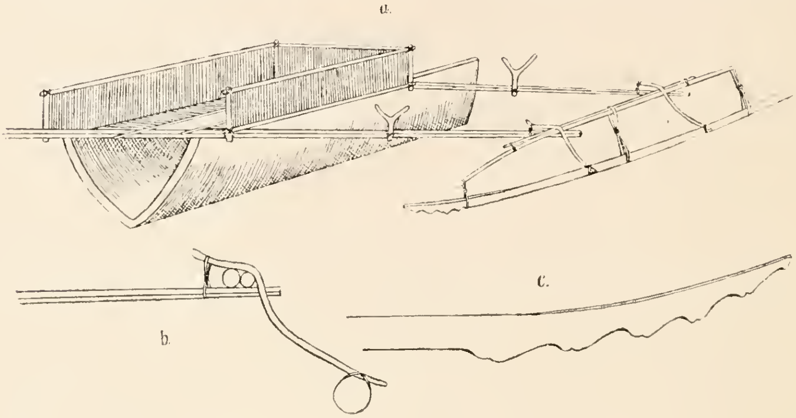


FIG. 31.—Outrigger frame characteristic of the Obi Islands. *a*. general view of the midships region of a passenger canoe; *b*. details of boom attachment. Two brace poles are shown in section under the elbow; *c*. carved fore end of float.

joint, the inner being the shorter. The float was a stout cylindrical jungle pole, slightly curved upwards at the anterior end and carved as shown in figure 31*c*.

BURU.

This large island lies about 80 miles south-south-west of the Obi Islands, 50 miles south-east of the Sula Islands and a lesser distance west of Ceram and Amboina.

The double outrigger is employed for most purposes; ordinary dugouts without outriggers are used in quiet water, while for heavy work beamy plank-built true boats are employed.

By far the most numerous outrigger is that with U-shaped secondaries—the Būrū type—generally withies, rarely stout rattan. The float is variable, either composed of one, two, or even three sago palm leaf-stalks or of a pole of light wood flattened below and convex above or else of a suitable length of bamboo. Such canoes have hulls made of comparatively short dugouts, usually with a washboard added, together with high projecting stern and stem pieces; some have a narrow slab-sided dugout for a basis; the others are flared and these are much wider amidships, as the wash-board continues and emphasizes the flare of the sides.

A second form of outrigger whereof only a single example was seen, had L-shaped secondaries; in each the lower or horizontal limb was turned outwards and lashed to the upper side of the float, transverse to it. The upper end of the vertical limb instead of being lashed to the side of the boom as is usual with secondaries, had its point inserted pegwise into a hole passing through the boom. To secure the joint, a long rattan connexion is made between the extreme end of the boom and the end of the horiz ontal limb (Fig. 32). The device is obviously a weak and inferior variation upon the U-design.

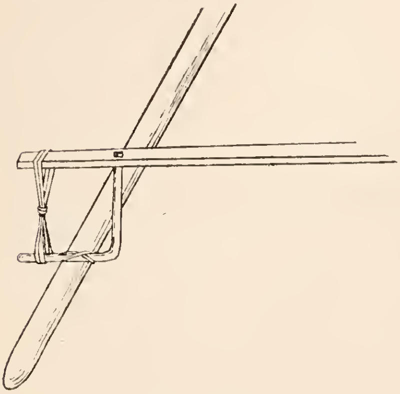


FIG. 32.—Variation in the U-attachment seen in Būrū.

Larger outrigger canoes, employed for heavier work, adopt the East Indonesian elbow joint as their type of secondary; these craft are fairly numerous. Two strengthening bracing poles are used, one without and the other within the elbow joint. The inner is the shorter; it runs parallel with its fellow and has a rattan connexion with it at each end and at midlength. The long outer brace is again connected by three rattan lashings with the float (Fig. 31*b*).

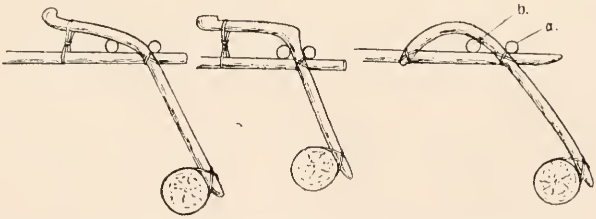


FIG. 33.—Varieties of the East Indonesian attachment seen at Būrū. *a.* outer brace pole; *b.* inner one.

These braces are tough thin poles. Their employment tends to stiffen the float and prevent it from working loose from the secondaries. Considerable variation is seen in the form of the angle and upper arm of the secondaries in different canoes; the three common forms are shown in figure 33; the first is the most numerous.

Whereas the smaller of the Būrū outriggers use steering paddles, the larger have a steering fitting or frame near the stern from which to suspend a quarter rudder. This frame consists of a stout thwart laid across the canoe and secured in the manner shown in figure, the gunwales being taken in recessed grooves. The end on the starboard side projects some inches outboard and in this is inserted a vertical peg, the upper end passing through the outer end of the stout elbow piece likewise inserted into the thwart (Fig. 34), and secured by a long lashing. The rudder of the form seen in figure 54 is hung by a rattan grommet upon the projecting end of the upright peg; its fore edge rests in a groove cut in the hinder margin of the outboard portion of the thwart behind the rudder peg.

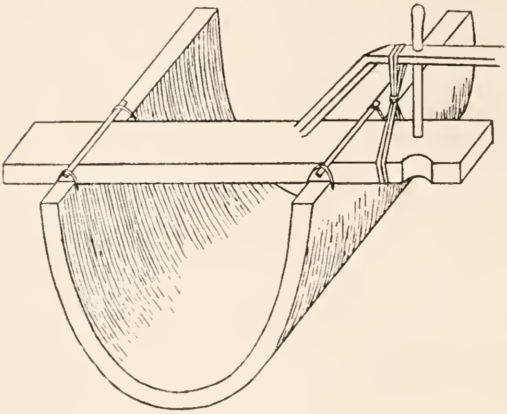


FIG. 34.—Section of a large Būrū outrigger hull showing the thwart that carries the peg from which is hung the quarter rudder.

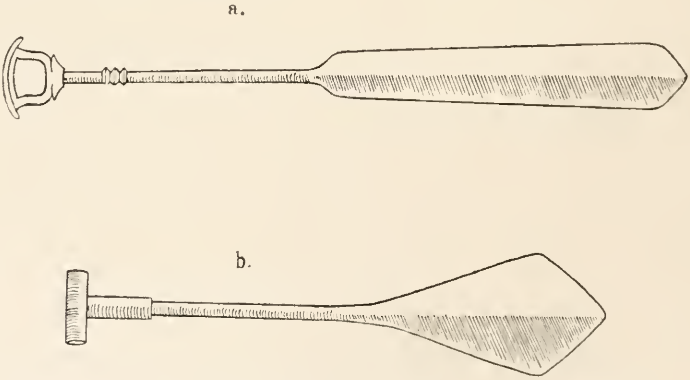


FIG. 35. Two forms of paddle used in Būrū. *a.* a rowing paddle ; *b.* a steering paddle.

The paddles in Būrū are varied and elegant in form. A common shape of steering paddle is represented in figure 35*a*; it has a perforated handle with carved shaft and long blade, thickened along the middle line. Rowing paddles have shorter and more angular blades (Fig. 35*b*).

Considerable variation prevails in the rig of these Būrū outriggers. The most common is the oblong sail, most primitive of those in use in these seas; sprit-sails running on the mast on rings are also fairly numerous; the cutter rig, with jib, is also coming into limited use, evidently copied from the modern pearling boats, one of which I saw here in harbour.

AMBOINA.

This once important centre of the far Eastern trade has been so long under intimate European influence that the use of outrigger canoes has been discarded for the coasting trade; they survive only for inshore fishing and ferry purposes. The great majority are particularly long and narrow slabsided dugouts, with weak outrigger frames. No wash-strake is normally provided. The outrigger booms are squared poles of small sectional dimensions. Each is secured to the canoe by a pair of rattan couplings passed around a thwart inserted low down in the well of the dugout and secured there by being jammed under two wooden chocks or cleats left standing when the interior was roughed out (Fig. 36 on page 66). The floats are usually made of the large leaf-stalks of the sago palm, the narrow end directed forwards. The floats are connected with the booms by means of egg-shaped loops made of rattan in the case of the smaller dugouts, and of stout withies in that of the larger; the base of each loop is lashed to the upper surface of the boom while the ends are crossed over one another above and lashed together; the two limbs are tied against one side of a boom near its extremity.

The two booms are fitted about equidistant respectively from stem and stern; the length of each float is roughly equal to double the distance of the float from the midline of the dugout.

CERAM.

The adjoining island of Ceram is much larger than Amboina and has been much less under longstanding European influence. Hence I was not surprised to find the outrigger type more in evidence and more varied in design than in the latter island.

Three varieties of outriggers are present; they show considerable diversity in pattern, with affinity on the one side with Amboina and with Būrū on the other.

The first variety is of the true Amboina type with withy loop secondary ; it needs no further description.

The second approaches the Būrū U-shape in the form of the secondary, but instead of being of withy or of rattan it is made from a natural angle of timber, with a flat base ; this enables it to be lashed more securely upon the upper surface of the float when the latter is solid (Fig. 37*a*). The two arms are attached to the boom in the usual Būrū fashion. In canoes where the floats consist of bamboo, the base of the U-fork is prolonged into a short stout peg ; this is inserted into a hole cut in the bamboo, a device which contributes considerably to provide a strong and safe attachment (Fig. 37*b*).

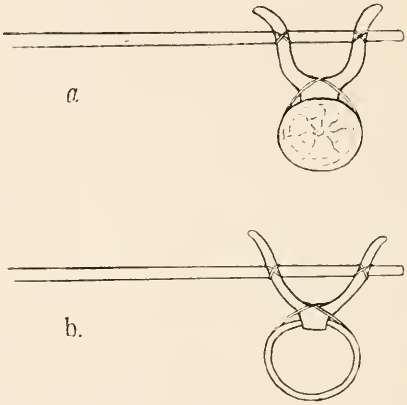


FIG. 37.—Two forms of the Ceram variety of the U-attachment (the booms shown in transverse section).

The third type of outrigger is one of the innumerable variations of the East Indonesian design. It has the usual two booms, with a float on each side, the connexion being made by an oblique-elbowed secondary of the peculiar form figured below. (Fig. 38). The long limb is nearly straight, and is lashed to the outer upper surface of the shaped timber float. A distinct knuckle is present on the upper side of the elbow ; the free extremity of the short limb is secured in position by a long lashing to the boom. A *single* tough brace lies across the ends of the two booms, within the angles of the joints ; unlike those previously described, there are only two long lashings coupling the float with the brace, one near each end ; by the tightness of the lashings the gentle curve given to both ends of each float when shaped is retained,

thereby reducing resistance when sailing as well as contributing to the general strength and rigidity of structure as a whole; these braces are of the nature of stays and it is noteworthy that their use is confined to outriggers of the East Indonesian design—those with oblique secondaries.

The anterior portion of the brace pole is usually ornamented by the cutting of a series of three incised rings, the extremity being mango shaped. The fore end of the float is deep and narrow in section, forward of the front lashing, with the upper surface ridged

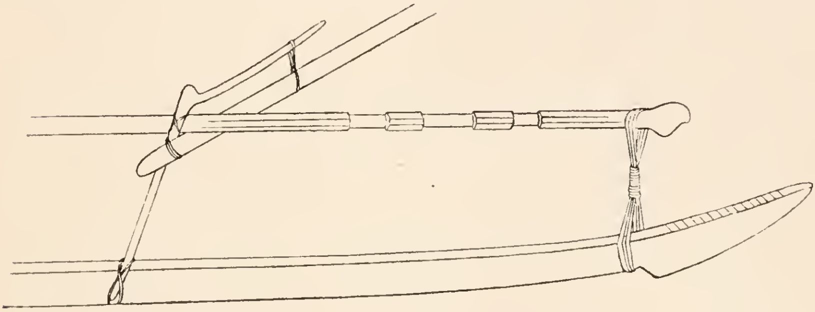


FIG. 38.—Fore end of outrigger frame. Ceram.

in the centre, with incised herring-bone decoration (Fig. 38) on the two sloping faces. At the hinder end of this short stretch of incised pattern the transverse section of the float becomes nearly cylindrical but less deep than the fore end.

SULA ISLANDS.

These islands lie midway between Būrū and the western coast of the Celebes, and are not to be confounded with the Sūlū Archipelago, between the Philippines and Borneo. Their outrigger canoes conform entirely to the East Indonesian type; none is found either of the Būrū or the Amboina types. Those of Sanana, the principal town in Sula Besi island, are typical of the local variety. The ends of all are brought in very fine, and in the large ones great sheer is given. Wash-strakes are added to almost all; as little flare is given, the end view is extremely elegant and remarkably like that of a modern 'ocean greyhound' as seen in dry dock. In some, the sheer is so great that the bottom of the canoe forms almost a segment of a circle, running sharp and

fine at each end (Fig. 39). The larger ones run to 35 feet in length. They often have an atap roof for shelter amidships; in these the space available is increased by building out over the

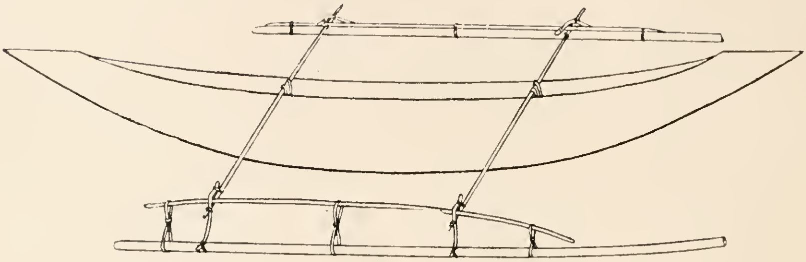


FIG. 39.—An outrigger canoe, Sanana, Sula Islands.

outrigger booms upon a longitudinal pole laid athwart the booms a foot or so outboard on each side.

In all but the smallest outriggers four crutches are inserted in the booms about a foot outboard, to take spare bamboos, poling sticks, etc. In many, these crutches have a faint suggestion in their shape of a bird motif and in a few this is emphasized unmistakably (Fig. 40).

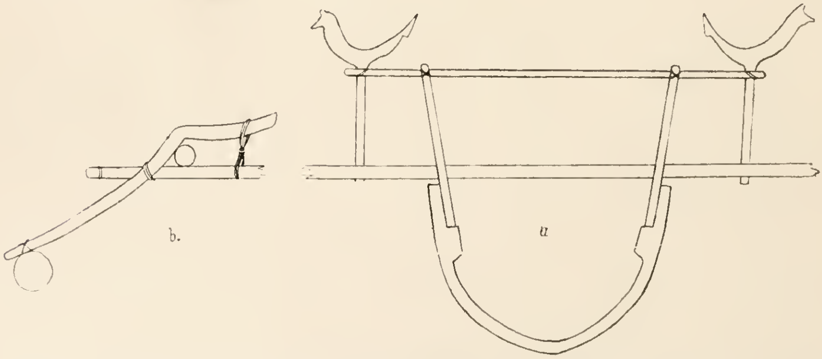


FIG. 40.—*a*. Diagram of the transverse section of a Sula outrigger to show cabin framework and bird-shaped crutches; *b*. attachment method of outrigger secondary.

By means of two transverse poles lashed below the forks of the forward and aft pairs of crutches respectively, each further supported by two nearly upright stays stepped on two projecting cleats inside the canoe, a simple framing is made (Fig. 40), which by the addition of a king post in the centre at each end and of a longitudinal ridge pole, can be used when necessary to support an atap (palm leaf) roof.

The outrigger frame approaches the third design described from Ceram so far as the number and arrangement of the parts are concerned. In detail there are numerous differences ; no ornamentation of the single bracing pole on each side or of the fore ends of the floats is attempted ; the floats are generally bamboos, the fore end projecting much beyond that of the brace pole and extending forwards almost level with the stem of the canoe ; three rattan lashings connect each brace and float. Most notable of all, the long limb of the angular secondary is extremely oblique and of greater relative length than in that used in Ceram ; in this it approaches the form seen in Batjan and in many places in Halmaheira. In the neighbouring Mangoli Island, the outrigger canoes do not generally run so fine as at Sanana, neither is the sheer so pronounced. The hull is always a dugout ; a wash-strake is usually added but rarely any stem and stern pieces in those used for work in sheltered bays.

One brace-pole only is employed on each side ; the bamboo floats are greatly elongated at the fore end as at Sanana, and bent upwards by the pull of the brace. The curve of the oblique secondary is rather more marked than in that of Sanana. The booms are of squared poles.

The paddles are long in the blade and sometimes have elegantly carved handles. One especially, seen at Vesuvius Bay, was particularly well designed. The majority have however a plain cross bar for handle.

For heavy work, beamy shallow boats, built up on a dugout base, with flared planked sides are employed generally. They employ two quarter rudders often ornamented with carving. Such boats are generally provided fore and aft with a simple arched cross piece supported on two oblique lateral posts ; by means of reeper poles laid lengthwise over these arches, the framework of a cabin can be put up quickly ; when thatched with atap leaves, this forms a shelter, proof alike against sun and rain. A point of much interest in regard to the Sula Islands is the fact that although they are comparatively close to the northern end of the Celebes, the distinctive outrigger form of that region (Minahasa) is unknown ; in 1916 a Minahasan outrigger was thrown ashore and was a source of wonder to the Sula coast folk who had never seen one before, and who could not imagine where it came from. Trade connexion here is chiefly with the east and not with the west.

THE PHILIPPINE ISLANDS.

Before turning our attention to the smaller sea-craft of the Celebes, it is desirable to see what types are in use in the Philippine islands and their dependency, the Sulu Archipelago. I have not had an opportunity to visit this locality, but fortunately, thanks to the courtesy of Mr. Alvin Seale, formerly Director of the Fisheries section of the Bureau of Science there, and of Colonel O. C. Waloe, commanding the constabulary in Mindanao, I have at my disposal a fine series of photographs and valuable notes upon points of detail. The Bureau of Science, Manilla, has also kindly supplied a valuable set of fine photographs.

With few exceptions Philippine outriggers belong to the direct attachment group, and with merely occasional exception of no significance they are all of the double type. They separate readily into two main sections, which I shall term respectively the Philippine and Sulu sub-types. The latter centre in the Sulu Islands, their range extending approximately as far north as Sindañgan Bay on the Zamboanga Peninsula of Mindanao, eastwards as far as Sarangani Island, and on the south including the whole of the islands in the Sulu and Tawi-Tawi groups. The Philippine sub-type covers the whole of the remainder of the Archipelago to the northward.

The true Philippine outriggers are of an extremely simple design marked off sharply from the highly complex and ornate pattern favoured in Sulu. They vary greatly in size, from small dugouts used for inshore fishing (Pl. IV, fig. VII) to large built-up boats employed for interisland navigation. The latter are rigged with one or even two large principal sails and usually carry a jib (Pl. V, fig. VIII). The general design of hull is the same throughout, having as a base a hollowed-out log or dugout; in the larger, plank sides are raised upon the edges. The outrigger booms, made of tough wood, are normally two in number; their outer ends on either side are secured by neatly made rattan lashings to the upper surfaces of from one to five bamboo poles, forming the float. Those intended for sailing have the sides built up by securing to the upper edge of the hull, panels of stout matting, woven from strips of split bamboo, supported by stanchions at intervals, the whole made watertight by a preparation of resin. The booms do not pass through the body of the boat but lie upon the upper edges, secured thereto by rattan lashings; they pass consequently through the bamboo weather-matting and so seem to project from out the

body of the boat. The general appearance of such a craft built up with high matting bulwarks supported by numerous stanchions and stays has a distinct resemblance to the much larger outrigger-ships seen in the Buddhist sculptures of Boro-Budur in Java to be referred to on a later page.

Single outrigger canoes are sometimes seen, especially in Manilla harbour, but these are local and are apparently so modified for ease in moving in and out of crowded harbour waters and for convenience in carrying passengers between the shore and ships at anchor.

The Sulu sub-type.—This design is most elaborate in detail and the owners are lavish in its ornamentation.

With differences in size and locality, there are as usual, minor variations in the detail of the fittings ; for the present purpose we shall take as the central type a medium-sized *vinta*, as these boats are called, capable of voyages extending to four and five-day trips and much used on account of their speed in smuggling between the Sulu Islands and British North Borneo (Pl. VI, fig. X).

The hull consists of a dugout (Samal-Moro dialect = *dalamat*), the sides raised by means of two wash-strakes *(tapi)* sewn on with coir yarn. The ends are bifid. The lower projection of the prow *(munda)* is nearly horizontal ending sharply in ordinary canoe fashion ; the upper projection has a wide cuneate board attached to its upper edge, prolonging it upwards (Pl. VI, fig. X) ; this board *(sangpad)* is usually decorated with fringed cloth. The bifurcated stern *(boli)* is much more elaborate and shows great artistic skill in the carving of the handsome pierced ornamentation *(pansal)* of both the horizontal and the upwardly sloping branches. The former is the true hinder end of the dugout and the edges are carved out of the solid in an elegant conventional foliate design.

The upper branch of the stern consists of two lateral and slightly divergent wings of perforated woodwork, carved in a bold foliate pattern, as shown in Pl. VIII, fig. XIV. Strengthening transverse bars or struts prevent these carved wings from being broken (Pl. VI, fig. XI).

The outrigger frame consists of either three or four booms directly attached to a bamboo float on each side of the canoe. The forward and aft booms *(batañgan)* are shaped from long poles which pass through the canoe and have one end attached to the port float and the other to the starboard one. The centre boom *(tarrik)* or booms—there may be either one or two—are, on the

contrary, each in two pieces, one to each side; the inner end of each half is lashed with rattan to a stout crossbar or thwart, morticed into the side of the dugout (Pl. VII, fig. XII). All the booms pass through the lower of the two wash-strakes sewn upon the edges of the dugout basis.

The fore and the aft booms are straight poles; the centre one (in those with three booms—the usual number) is curved downwards towards its distal end in small and medium-sized boats; in the largest sizes it may be straight with an L-shaped arm or intermediary passing down to the float, which in such cases is made usually of three stout bamboos lashed side by side. This L-arm is cut from a naturally-grown bend. To keep the booms rigid an ingenious system of braces is employed. Those fitted to the fore and the aft booms are bow-shaped squared timbers, which are lashed firmly athwart the canoe, concave side upwards, and immediately above the booms (Pls. VI and VII, figs. XI and XIII).

Three or sometimes four nearly vertical rods are intercalated at intervals between the brace and the boom, carefully and neatly served with rattan in order to keep them in position. The object of this device is to maintain the boom straight and to prevent it from becoming bent upwards as is its tendency owing to the frequent upward thrust on its extremity when in rough water or when a surge passes under the canoe. The extremities of the stout transverse brace timbers are usually expanded into ornamented heads, carved to match the decoration of the stern (Pl. VII, fig. XIII). Y-shaped crutches are also inserted in holes in these braces, to carry the mast and other gear. In large boats an elliptical crutch frame—a double bow—is fitted near the stern for the same purpose.

In boats with three booms, the median one, composed of two sections as already noted, is braced in a different manner; each section of the boom when it passes outwards from the side of the canoe is inclined slightly upwards; hence the brace used here is straight. It passes athwart the hull and at each end is lashed to the upper side of the boom on that side; one or two short struts are placed between the brace and the boom to keep them rigid.

In boats with four booms, the whole four are sometimes composed each of one entire pole; in such case the inverted bow-brace is used for all. In others the first, third and fourth booms are of this discription, the second only having the straight brace described above.

It may be useful here to note the terms used in the Samal-Moro dialect for the various parts of these boats, as kindly supplied by Colonel Waloe. They are as follows:—

Outrigger boat	vinta.
Dugout body of the boat	delamat.
Bottom of the dugout	tadas.
Bow	munda.
Stern	boli.
The two wash-strakes	tapi.
Outrigger boom at each end of hull ...	batangan.
Median or amidship boom	tarrik.
Brace on top of boom	mandatang.
Outrigger float	katig.
Rattan lashing boom to float	buay pumukus sakatik.
Ornamental carved work at stern ...	pansal.
Do. at bow ...	sangpad.
Carved scroll along edge of dugout ...	pangambal.
Mast	taduk.
Sprit	tuklug.
Mainsail boom	bajo.
Guy rope to mast	baligtang.
Sail	banug.
Paddle	bugsay.
Nipa covering to cabin	kadiang.
Cabin floor of bamboo slats	lantay.

Several of these appear to be of Spanish origin, but the majority are of Malay derivation.

A cruder and more primitive form of the Minahasa type of hermaphrodite outrigger (*infra*, p. 85) is met with at Las Palmas, Mindanao. Its characteristics are clearly shown in figure IX, on plate V. It is probably the parent form of the type, indicating its original home. From a study of the boat forms of the North Celebes region, I infer that there has been immigration thereto from the Philippines.

THE CELEBES ISLANDS.

When we pass to the Celebes we find much greater diversity in double outrigger canoes and boats than in the Moluccas. The fishermen use them if possible even more extensively and for light coasting purposes in several parts, particularly in the north, large outriggers still continue the struggle with the schooner-rigged, high-sterned praus that have monopolized this trade in the south.

Everywhere the East Indonesian type is found; it is the one employed for weight carrying. Side by side with it exist several other types, usually with definite utilities. In the north these consist of the highly specialized Minahasa fishing canoe and a ferry type with floats directly lashed to the booms. In the south, the latter is also found, together with a second and very distinct variety of the same type. In addition there are very peculiar and strictly localized types in certain of the small islands. Single outriggers are also occasionally met with in the south, never in the north; they seem a recent modification evolved for greater handiness in harbour use.

Minahasa.—This is the most easterly district in the long narrow peninsula that stretches east and north towards the Philippines, with which it seems formerly to have linked by way of the Sangir Islands. The Minahasa is a wonderfully fertile region peopled by an enterprising race; head hunters and animists two or three generations ago, they have adopted in a suitably modified form many European manners and customs and now form a prosperous and self-respecting Christianized community. In fishing and boat designs little or no change has taken place, partly because coast work is principally in the hands of men of rather different ethnic origin, and partly because the craft in use are admirably fitted to local conditions and to the unambitions nature of their fishing pursuits.

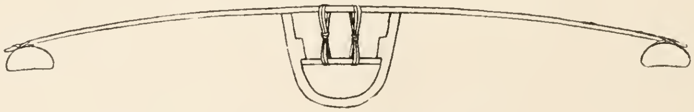


FIG. 41.—Simple form of outrigger with direct attachment: seen in section. Menado, N. Celebes.

At Menado, the principal port, the three different types of outrigger in use on the Minahasa coast are seen in considerable numbers. The simplest is used chiefly for ferry purposes and in taking passengers to and from the steamers in the harbour. These are simple dugouts with two long and slightly curved boom poles laid athwart the gunwales, with a bamboo float lashed to the ends on each side (Fig. 41). They vary greatly in size, river ones generally small, harbour ones usually hewn from very big tree trunks and capable of carrying numerous passengers with a considerable quantity of baggage. The hull is perfectly plain; as a rule a sail is not employed.

The second type here is a stoutly built and usually fairly large dugout fitted with double outriggers of the East Indonesian pattern (Pl. VIII, fig. XV). The hull is double ended, with little sheer, rather coarse at the extremities; the stem and stern are bent upwards a few inches only; these are separate pieces added to the dugout hull. No ornament of any description is present. The booms are of squared timber supported on chocks resting on the gunwales; they are secured by lashing to thwarts near the bottom of the canoe; the floats are strong bamboos. The angular secondaries have the lower limb rather more curved than is usual in the Molucca varieties; in the Minahasa design the whole joint often assumes a loose S-shape, formed of two reversed curves. Another notable difference is the lack of any bracing pole in the Minahasa design. A curious substitute for the usual wooden secondary was seen once in a small-sized canoe of this description on the Menado river, the branched antler of a deer being used. It is just possible that in this we have the primitive form and material used to make the curved joint; the natural curve of an antler is very suitable for the purpose, and its toughness furnishes the requisite strength. The use of antlers in fashioning canoe anchors is not uncommon in the Moluccas; I noticed several instances.

In some cases a Y-crutch is lashed against the boom just beyond the head of the secondary to which it is also lashed (Pl. VIII, fig. XV); this gives a certain additional stiffness to the joint but many are without it. Poles, paddles, and fishing rods not in use are conveniently placed out of the way in these rests.

These canoes are the weight carriers in fishing; they are far less handy and speedy than the third form yet to be described, but their stouter build fits them to carry heavy loads of nets. As a consequence these boats are used wherever seining is a fishing method much used, and that signifies nearly everywhere on the Minahasa coast. Frequently these canoes work in partnership with the light third type; the one shoots the heavy seine; the other carries one of the hauling ropes to the appointed place. In this way the seine can be used in deep water somewhat in the manner of the Danish trawl.

Occasionally larger outrigger canoes are built on the same general design to carry light but bulky cargo such as thatching material, upon outboard side platforms laid over the booms. One of these (Pl. IX, fig. XVI) had a big slab-sided dugout as the basis

of the hull; sides of some height were raised on this, by the addition of several strakes and with a broader narrow wale on top, forming a prominent beading, with a narrow gunwale to finish off. It carried a permanent pole mast, and an atap roof over the waist to give shelter for the crew, and was steered by means of a quarter

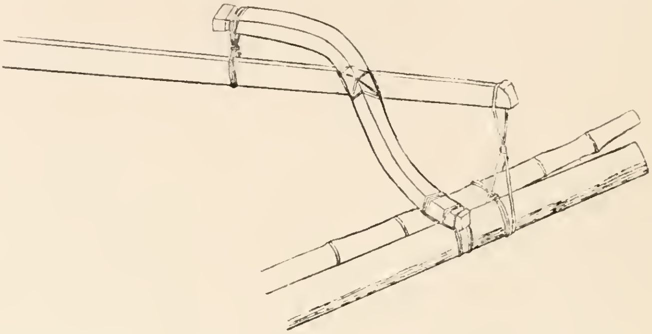


FIG. 42.—Attachment used for the fore and aft booms in small coasters, Minahasa, N. Celebes.

rudder suspended from a strong pin in an aft rudder thwart, as is often seen in the smaller Macassar boats.

The outrigger frame consisted of three massive squared boom poles attached to the floats by very stout reverse-curve secondaries in the case of the forward and the aft pole (fig. 42), and by a weak

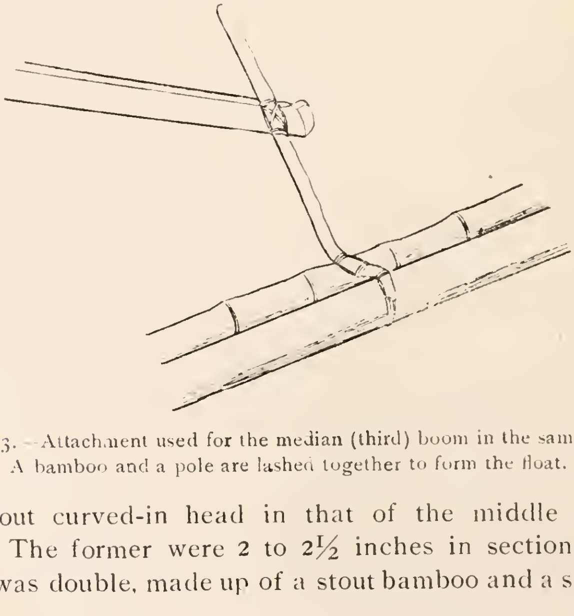


FIG. 43.—Attachment used for the median (third) boom in the same boats. A bamboo and a pole are lashed together to form the float.

joint without curved-in head in that of the middle cross pole (Fig. 43). The former were 2 to 2½ inches in section. Each of the floats was double, made up of a stout bamboo and a stout timber pole.

The cargo platforms were made by laying several poles longitudinally over the three booms; on these a cargo of atap thatch mats was stowed. Stem and stern were vertical and without sheer. No ornament anywhere except for the beading below the gunwale.

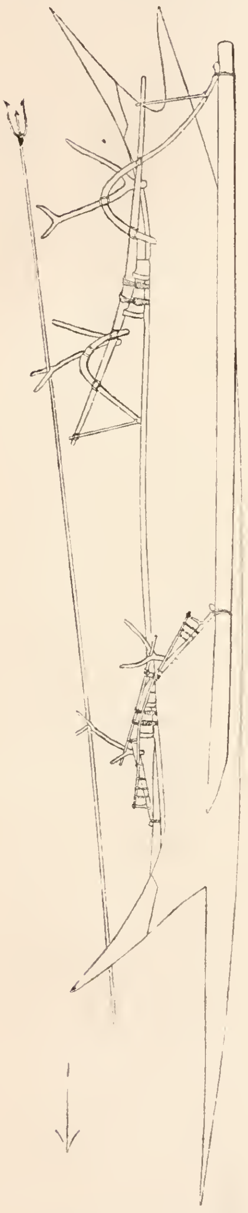


Fig. 44.—A Minahasa fishing canoe; side view.

The third kind of outrigger canoes in use in Minahasa is a strictly localized design not seen far beyond the strict territorial limits of the district. It is extremely specialized and may be termed the *Minahasa type* (Pl. IX, fig. XVII). It is of great importance in its own locality, hundreds being in constant and universal use in all fishing operations where speed is necessary and where roominess and weight-carrying are not requisites.

Description is difficult on account of the extraordinary complex character of the many details. The following account if taken in conjunction with the diagrams furnished (Figs. 44 and 45) will, it is hoped, convey comprehension of the characteristic features of greater importance. Two booms are employed. The fore one is rectangular in section, decreasing slightly in thickness towards the extremities. By means described later, the ends are bent down in a graceful curve on each side so that the whole forms a bow-shaped arc; the extremities are connected directly by lashing with a float on each side. In addition there are two horizontal tough braces or stringers provided with a view to keep the curve of the boom in correct set, counteracting the tendency to straighten through the thrust from below set up by the force of the sea upon the float, particularly when pitching. The longer of these added pieces is nearly the same length as the boom to which it is lashed amidships. It is straight and at each

end where it stands out free some three inches above the end of the boom, a small inverted forked Y-piece, from two to three

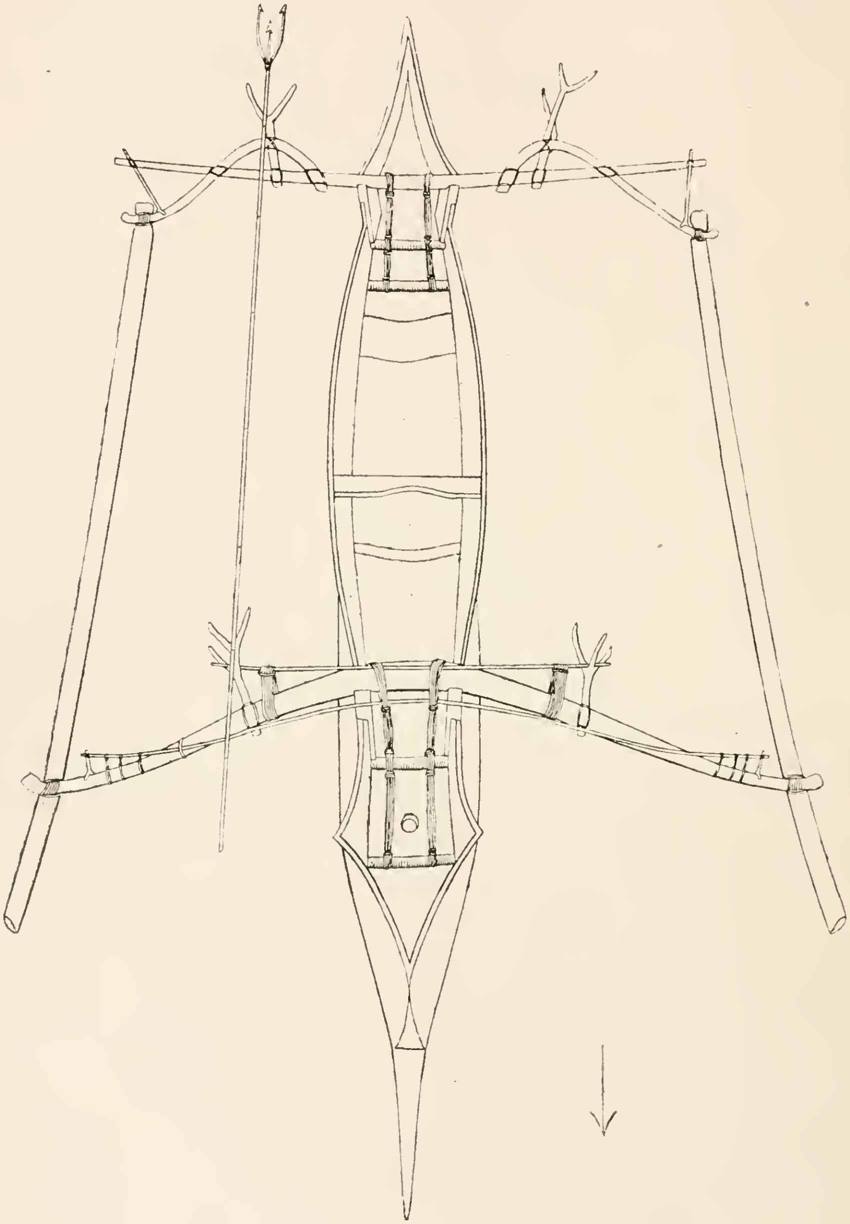


FIG. 45.—A Minahasa fishing canoe seen from above.

inches long, is inserted; at the top end it is lashed to the end of the brace, while the forked end straddles the extremity of the

boom. In addition there are three or four lashings at short intervals on the inner side of the Y-piece, as shown in figures 44 and 45.

The second transverse brace is much shorter; it extends outboard on each side to midway between the gunwale and the end of the boom, that is, to just beyond the three-branched pole crutch yet to be described. In the lower fork of this, at a height of two to three inches above the down-curving boom, one end of the brace is lashed; inboard are usually three lashings as at the ends of the longer brace. Both the brace poles are slender.

The aft boom is without these braces and is not fastened directly to the floats. Instead, a reverse curve bracket of the kind described on page 81 is employed as connecting joint—a method employed for both booms in the heavier outrigger used in seining in the same district. In the present instance there are several elaborations; the inner end is prolonged to a point inboard of the place where the three-branched pole is placed, *i.e.*, it extends further towards the gunwale than is usual. To secure the further end where it joins the float from bending and perhaps breaking in a heavy sea, a long vertical inverted forked stick is inserted as a strut between the end of the boom and the outer end of the joint piece just inner to its attachment by lashing with the float—in similar manner to that described above in respect of the short Y-peg at each end of the fore boom.

The rig consists of a short pole mast carrying an oblong sail with a bamboo along each of the long sides—the sail of the Boro Budur sculptures.

The hull is invariably a dugout, narrower at the gunwale than at the bilge. The usual measurements are about 22 feet in length by 16-inch beam at the gunwale. Stem and stern are bifid, a wedge shaped piece being cut out from each end. The gap thus formed is deeper and longer at the fore end than that at the stern. So deep is the former that it suggests instructively the open jaws of a crocodile. Whether it had this meaning originally, it certainly approximates in outline to the highly ornamental bow given to their canoes by the Papuans of the north-west of New Guinea. On the northern Celebes coast, the parts are simplified and no ornament is employed. The similarity of the basal design is significant. This type extends westward along the coast as far

at least as Paleleh, where I saw a considerable number. It may be however that they are imported as the steamer I travelled by landed one here which had been shipped at Amurang. These boats are largely used in fishing (trolling) for bonito, a purpose for which they are well adapted by reason of their fine lines and high speed under full sail.

Before quitting the Minahasa, it is worthy of note that the canoes used on the extensive inland lake of Tondano, the heart of this region, are dugouts of the most primitive design, and wholly without any visible relationship with any of the sea craft of the same region. They are trough-shaped dugouts, truncate at the ends which are hewn through, a cross bulkhead being afterwards put in to close the open extremities. In some cases the hull is straight, in others the ends rise distinctly and this makes such canoes easier to propel. The paddles used are made from split bamboo roughly shaped into handle and blade.

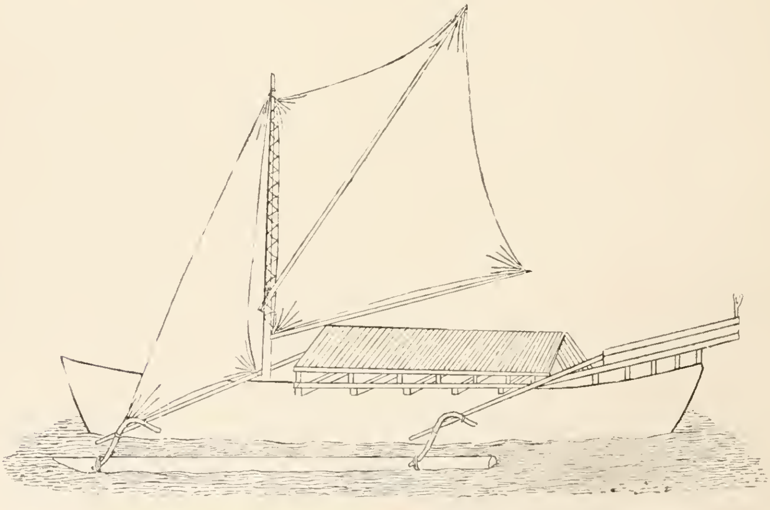


FIG. 46.--A large outrigger coaster, N.-W. Coast of Celebes.

N.-W. Celebes Coast.—On the northern part of the west coast of the Celebes, from Paleleh to beyond Donggala, besides fishing canoes fitted with the East Indonesian type of outrigger as in use at Menado, much larger craft of the same basal design are extensively employed in the local coasting trade. They run to a fair size—10 to 12 tons each. The hull is plank-built, sharp at

both ends, with a stern platform, the rudiment of a poop (Fig. 46). This superstructure is here seen for the first time, although it is usual in an even more developed form in Macassar praus without outrigger. It is carried out several feet beyond the stern post and projects well over the quarters. The sides are low, formed of narrow planks, four to six inches deep. A crutch sometimes supported by an arc-shaped rail, is usually fitted at the centre of the aft end, to take the long sprit when not in use. This elevated stern platform gives the tindal or the pilot a clear outlook forward, and from it he can readily transmit his orders to the steersman below who manipulates the quarter rudder. The aft platform is sometimes provided with a temporary mat roof, penthouse form.

Amidships is the main cabin, wider than the hull proper which carries the low openwork sides upon thwart beams projecting a foot or so outboard beyond the gunwale proper. The roof is a low atap covered penthouse, the boom of the mainsail being raised sufficiently high to clear it.

The construction of the open-frame sides when extended and amplified would result in such a basketwork superstructure as is seen in the Boro Budur sculptured ships, where it is evident that the hull proper is narrow in comparison with the width of the superstructure—a method or design which necessitates the use of double outriggers. To guard as much as possible against top-heaviness, the added parts are made as light as possible, exactly as is seen in the openwork bulwarks of Macassar praus, each plank being spaced about its own width apart from the adjoining plank above and below.

The rig of these boats consists of a comparatively short mast stepped well forward, carrying a boomed spritsail and a peculiar fore staysail. The sprit is comparatively long; the boom is fitted fairly high, to enable it to clear the cabin roof. As there is no bowsprit, the forward corner of the jib-like staysail, when running with a fair wind, is attached to the outboard end of the forward outrigger boom on the weather side (Fig. 46). In fishing boats of the same design the tripod mast hoisting an oblong sail is occasionally to be seen, for example at Paleleh.

Macassar and Southern Celebes Coast.—On the southern coast of the Celebes, dominated by the great entrepôt of Macassar, great diversity of type exists. Among the larger fishing boats

met with off the coast for many miles northward of Macassar, the commonest is a variety of the East-Indonesian design where the secondaries approach more closely to a form common in Lombok than to those seen on the northern coasts of the Celebes or anywhere in the Moluccas. Instead of the upper limb being straight or only slightly bent, it is so greatly curved that the extremity is bent down to the side of the boom and lashed thereto; as the part which in other varieties forms a distinct elbow, is also here lashed to the side of the boom (Fig. 47), this design gives great security and the use of bracing poles is dispensed with. The long or outer arm of the joint is distinctly more elongated than usual and is placed very obliquely, enabling the float to be attached well beyond the ends of the booms. This design is employed by all the larger fishing canoes that work the offshore waters.

These large craft have a slabsided dugout hull, sometimes heightened by a wash-strake; sharp at both ends with little or no sheer. They always have a double outrigger and while the great majority have but two booms, a few were seen with three. In this case the extra or middle boom is placed well aft. The attachment of the booms to the dugout is often effected differently from that in general use among the types so far described; here a narrow

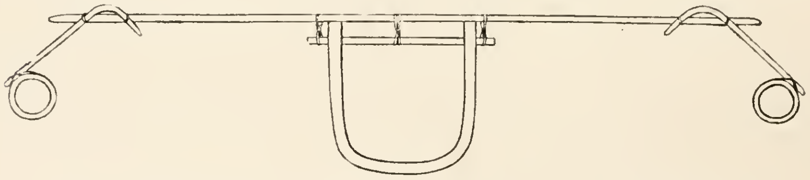


FIG 47.—Diagrammatic transverse section through a Macassar outrigger dugout.

thwart passes on each side through the gunwale and to this in three places—one inside and two outside—the boom is lashed (Fig. 47). Stout bamboos are used as floats.

The greater number are rigged with a bamboo tripod mast and oblong sail. This mast hinges at the base in the manner already described (page 60) and can be folded down to rest in a crutch at the stern. All three legs are attached very far forward, the paired ones immediately in front of the fore boom, the odd leg right in the bow. The truck where the two side poles meet is finished off with a backward curl at the summit. Others have adopted a rather tall pole mast; these are generally rigged with a

sprit sail laced to the mast and without boom; some however while adopting the pole mast have adhered to the older pattern of oblong sail.

At the stern a crescentic frame carrying two lateral crutches is usually fitted; on this the mast and sail rest when not set up. Inner to each lateral crutch a peg is let into the frame on which the quarter rudder is hung by a rope or rattan grommet (Fig. 48). Usually only one quarter rudder is employed.

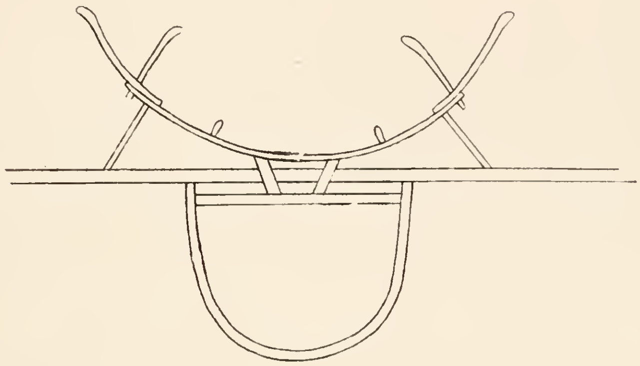


FIG. 48.—Sectional view through the aft end of a Macassar outrigger cance to show the steering framework.

Among smaller double outriggers used in Macassar and the neighbourhood are those with the booms attached directly to the float. In these, both the booms and the floats are of bamboo, the booms depressed outboard somewhat to ensure that the floats are sufficiently low to reach the water readily. Alternatively the booms are nearly straight, and to depress the floats enough a stout wooden chock is intercalated between at the point where the boom end is lashed to the float (Pl. X, fig. XVIII). Some canoes with this kind of outrigger have fairly large stout hulls with end pieces and a stout wash-strake added. The sharp ends are coarse and heavy and nearly vertical. The gunwale is almost without sheer throughout its whole length. These canoes carry a pole mast stepped immediately abaft the fore boom; a sprit sail is the usual rig.

The smallest-sized fishing boats used in inshore work range from 9 to 20 feet in length; *nearly all are single outriggers*, a most exceptional design in Indonesia. The form of attachment also is one not seen anywhere else in the Archipelago. The distinctive feature is the selection for each boom of a pole having a side branch

towards one end, divergent at the requisite angle. The prolongation of the main stem is cut off, and the pole with its branch is affixed across the canoe in such a way that the side branch is downward and directed outwards. When a pair are affixed a bamboo float is lashed to the ends of the two oblique side branches. Most of them have the arc-shaped stern crutch already described but the very small ones are provided with only half of this fitting. Some of the larger ones have in addition a Y-shaped crutch forward on one bow (Pl. X, fig. XIX). Others have a smaller one outboard on each side close to the forward boom; sometimes each of these Y-crutches is inserted near the anterior end of one of the bamboos laid longitudinally over the outrigger booms to form a rough outboard platform; sometimes in the outboard end of the mast thwart; much variation prevails in regard to the form and position of all these crutches. No ribs are left to strengthen the dugout hull when excavated, neither is it spread in any way. Some have a washstrake pegged on with long vertical pegs. These canoes generally use a sprit sail rigged on a pole mast; a few use the old oblong sail. Most use cotton sails, but mat ones still persist; a quarter rudder is the rule.

Occasionally but rarely one of the larger of these canoes is seen with a double outrigger of this last pattern.

On the river a few small dugouts with single outriggers are in use; in these the booms are naturally bent curved poles, tied directly to a palm leaf-stalk employed as a boom. These are two-man angling dugouts; small as they are, steering is done by means of a quarter rudder (Pl. XI, fig. XX).

South-East Celebes.—Still other forms of outriggers—all double—are found in the island of Būton and on the adjoining south-east coast of the Celebes mainland. The most common is that seen in Būton, where the fishing boats have the booms attached to the floats by means of hook-shaped secondaries, related to those of Macassar but differing essentially in that the long arm of the joint is vertical instead of oblique; in this way the float, which is lashed to the inner side of the vertical secondary, is directly below the end of the boom and not some distance beyond as is the general rule in East Indonesian designs (Fig. 49). The hulls of these Būton outriggers are narrow unspread dugouts; the smaller ones have very little freeboard, and are so low in the water that chocks, about four inches high, are pegged to the gunwale below the

booms to give these sufficient elevation to carry the floats at a suitable depth. The larger ones have a washstrake pegged on.

For passengers and ferry purposes, beamy plank-built boats fitted with the same kind of double outrigger are also employed. In these the length of the booms is relatively shorter than in the fishing canoes. Besides the booms three long thwarts cross the hull, projecting 18 or 20 inches outboard on each side. On these projections an outboard platform, with board sides and flooring of split bamboos, is erected, large enough to accommodate a number

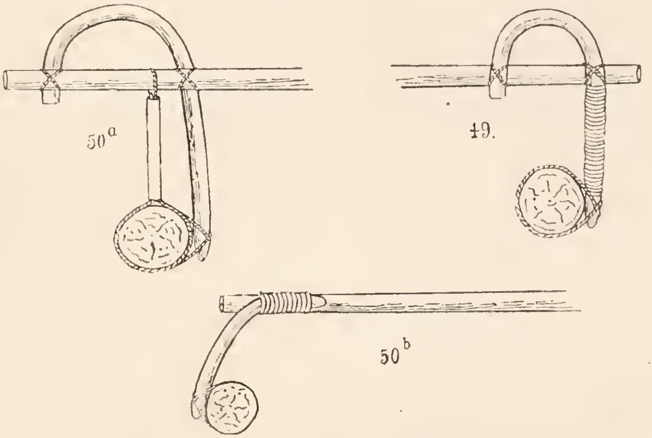


Fig. 49.—Attachment device seen at Būton, S.E. Celebes.

Fig. 50 *a* and *b*.—Two forms of attachment in use at Raha, same region; *a*. as used in large canoes; *b*. in small ones.

of passengers or to stow light cargo. To carry poles, paddles and other boat gear, four Y-shaped crutches are fitted upon the outboard ends of the two main thwarts. Two quarter rudders are used, each hung by a grommet from a peg in the upper side of a curved post fixed on each quarter. Forward are two small catheads, connected by a bar, used to support the mast and sail when not in use. The bow is straight. No ornament is employed whether in these passenger boats or in the fishing canoes.

At Raha, further north, the larger fishing canoes are double outriggers much like those of Būton but with the curved end of the hook-shaped secondary turned outwards, and with the float attached on the outer side of the vertical arm instead of on the inner; to give further strength to the joint, a straight strut—a short cylindrical length of wood—is tied vertically between the under side of the boom and the upper surface of the float (Fig. 50*a*).

The smaller canoes have sometimes a plain angular bend connecting the boom and the float, one arm lashed to the side of the boom, the other to the outer side of the float, as shown in figure 50 *b*.

WEST COAST OF BORNEO

Comparatively few outriggers are employed on this coast ; what there are, are of the East Indonesian type seen around Macassar. The majority of fishing boats here are either small dugouts without outriggers, or else shallow beamy plank-built boats, sharp at both ends ; the latter are rigged with a short pole mast and oblong sail, generally of cotton and sometimes of matting. Double quarter-rudders are employed as in Macassar praus. Steering is done with the one on the lee side, that to windward is often left immersed and untended—it acts as a sort of leeboard under these conditions.

LOMBOK.

In this island all the outrigger frames are double ; they are of two types, one which is typical of the adjoining island of Bali and one characteristic of Lombok.

The latter is a variety of the East Indonesian type and may appropriately be termed the Lombok variety thereof. The largest fishing canoes are of this design (Pl. XI, fig. XXI). In this,

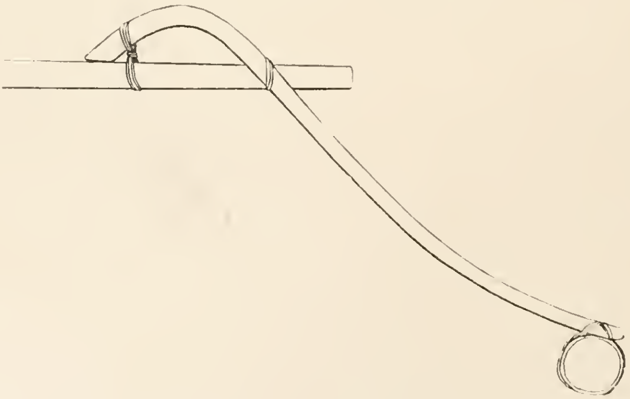


FIG. 51.—Method of connecting the boom and the float in Lombok outriggers.

the oblique outrigger secondary approaches the form seen around Macassar, but the free end of the curved head instead of being brought down past the side of the boom and there secured laterally, is cut to fit *upon* the convex upper surface of the boom to which it is strongly lashed (Fig. 51). The booms are stout

cylindrical poles of light wood ; in the centre, where they cross the canoe, they are secured in position in the manner so common in Indonesia, by long lashings to a thwart in the bottom of the boat, jammed beneath two lateral chocks left when hewing out the hull. To further strengthen this part, a batten extending outboard a short distance on each side is laid upon and parallel with the boom and seized thereto at each end (Fig. 52). Each of the floats is circular in section, of light wood ; the anterior end is curved upwards slightly, and the top surface sliced away.

One of these canoes was found to be 24 feet in length, and of 40 inches beam (to outside of gunwale) ; each float was placed 12 feet outboard, and its length was 19 feet. The length of the outer limb of the secondaries was 32 inches from the lashing near the outer end of the boom to the extremity where it was connected to the upper surface of the float. Sometimes these canoes run even

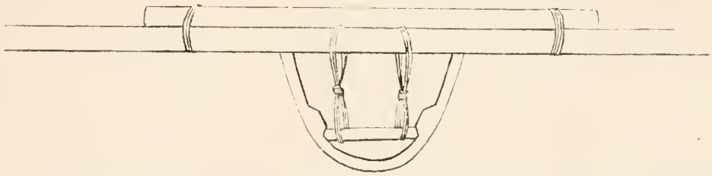


FIG. 52.—Method of lashing the boom within the hull of the dugout in Lombok outrigger canoes.

larger ; one seen but not measured possessed a small poop after the Macassar prau pattern ; this was in use as a small coaster. The hull has one or several strakes added to increase the freeboard of the dugout base, and both ends are sharp ; the stem is curved slightly forward, giving a moderate clipper bow—an unusual feature. Aft are one or several crutches ; the pattern and arrangement vary, in some there is one principal and median, carved neatly, in others three unornamented forked sticks are employed. A single quarter-rudder is used, hung from a peg inserted in an outwardly curving post rising from one end of a strong thwart that passes outboard nearly a foot on each side. A second curved post symmetric with the first is placed on the opposite side. A rudder notch worn smooth by constant use is cut in the fore edge of the outboard portion of the thwart to take the axis of the quarter rudder. Usually the rudder is hung to starboard ; in one case only was it on the port quarter. A pole mast is used, kept set up and fitted with permanent stays.

Smaller outrigger canoes are also seen of the Bali type, with spliced-on secondaries; they differ only in details (Pl. XII, fig. XXII). The hulls are dugouts with a narrow washstrake added, except forward of the fore boom. No added pieces are used at the stem and stern; each has a long blunt overhang carved from the original log. The booms rest upon stout blockshaped thwarts lying across the gunwales, and are secured to an inner thwart by two loop lashings as in the Lombok type. These canoes are largely employed in seining.

Alongside of these two forms of outriggers are many dugouts without this device. They are elegant in their form and lines; the stem is sharp and clipper-shaped, with the addition of a peculiar forwardly-directed heel, which may be compared with the bifid bow of the Madura and East Java 'sampans.' Right forward is an asymmetrical crutch; sometimes this is carved, the straight limb turned while the curved one sometimes has the terminal knob carved into the conventional representation of a bird's head. At the stern are a pair of curved elbows to carry the quarter rudder, used even in these small dugouts. When hauled up, a neatly made wooden rest is used to raise the hulls off the ground.

BALI.

This island, the last refuge of Hinduism in the archipelago, has a very distinctive design of outrigger in general use. This may be termed the Bali type (Pl. XII, fig. XXIII). The hull and rig may vary, but the essential points of the outrigger frame-work remain the same in all. These consist of the boom secondaries, lightly curved joints, spliced to the ends of straight booms at the inner ends, and inserted at their outer ones into holes bored obliquely through bamboo floats. The splice is a strong one, secured both by ample lashings and by a stout vertical peg, rarely by two, passing through the outer end of the splice. To prevent the floats working free from the ends of the joint pieces, a strong cord, secured at one end to the upper projecting end of the splice peg, passes along the side of the joint to be carried round the float and lashed firmly at the point of insertion of the pointed end of the joint. Figure 53 shows these details clearly. The booms are two in number, very stout and placed widely apart, the aft one very near the stern. In a medium-sized canoe, a dugout measured at Buleleng in Bali, the dimensions were:—length

30 feet, beam (outside gunwale) 40 inches, depth 30 inches; the floats were very stout bamboos, 6 inches in diameter; each projected 4 feet aft of the stern, the fore end being level with the bow. To lessen resistance, the anterior extremity of each bamboo float is closed with a bung-like wooden stopper, rounded in front.

The form of the hull varies. In the smaller and medium-sized ones, used chiefly in fishing, the form is canoe-shaped—sharp at both ends; those over 30 feet in length, running to 40 feet and

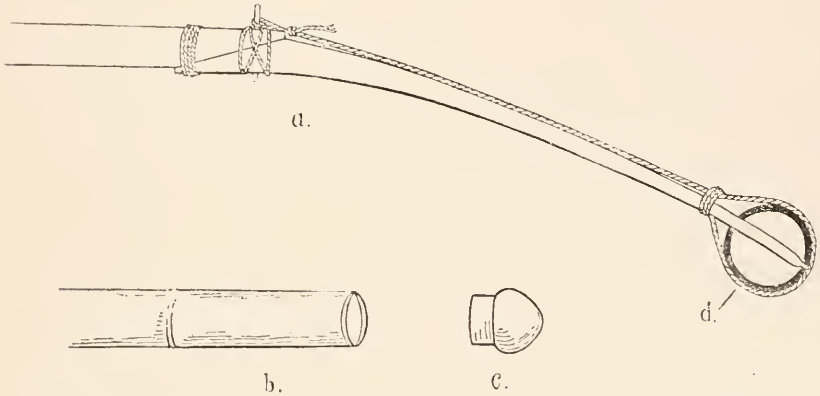


FIG. 53.—Typical Bali boom and float attachment: *a*. side view; *b*. fore end of the bamboo boom; *c*. wooden plug fitting into fore end of *b*.

more, are employed chiefly in trading; in these the bow is bifid, a narrow jibboom-like projection standing out in line with the gunwales, and above the actual stem. The stern is carried high in a great curve, by means of flattened pieces pegged on edgewise, giving a broad and striking appearance in side view. In the large sizes the depth and beam are increased by the addition of washstrakes. The bigger boats have an outboard platform fitted on each side extending out as far as a distance equal to or even exceeding the width of the dugout hull proper, which is narrow and deep—40 inches in one of 30 feet length. In some this is a light split bamboo platform with low sides, in others it is a permanent and substantial structure made of planking with fairly high sides supporting a penthouse roof of atap thatching. The whole structure rests on transverse thwarts passing outboard, and shows clearly how the lofty superstructure of the Boro Budur ships was formed. The openwork adopted in the latter was obviously for the sake of saving top weight.

The rig is similar to that of the passenger and cargo sampans of Sourabaya—a very short mast ending in a short peg, carries a triangular sail, apex downwards; the sail is hung from the peg by means of a loop of rope attached to the sailyard. All steer by means of a quarter rudder hung by a grommet from the lower horn of a Y-shaped crutch near the stern. This type of outrigger is derived without doubt directly from that in which each boom is formed from a pole having a curved branch on one side, the lower, as described on page 90. Such branches are difficult to procure of suitable size and strength in the requisite number—four of identical size for each equipment.

Outrigger canoes of similar design are met with in Lombok and in S.-E. Java (Banjuwangi).

A second type of double outrigger in which the ends of the booms are lashed directly to the float is also seen in Bali. It is employed generally for canoes of smaller size than those using the Bali design of spliced secondary, and is much less numerous. The design is all but identical with one of those common at Macassar. The hull is a simple slabsided dugout with the two ends sharp and similar. The booms are bamboo poles of considerable length. To secure them in position at a proper height, a thick thwart is laid across the gunwales; in the upper surface a groove is cut and in this the outrigger pole is laid and lashed in the usual manner. The outer ends of the booms are lashed to the outrigger bamboo directly; no special device is used. The only interesting feature is the employment of a carved ornamental piece, added at each end of the canoe; the design is floral, akin to the exuberant floral sculptures used in the decoration of the flamboyant temple gateways so characteristic of this island. A Y-shaped crutch is used to suspend the single quarter rudder used by these canoes. A sprit-sail rig is usually adopted; a light boom extends the lower edge of the sail.

A third kind seen in Bali is rare and of very small size, 14 feet in length in the one measured at Buleleng. In some ways it is the most interesting as it is one of those exceptional designs where the attachment to the float of the fore boom differs from that of the aft one (Pl. XIII, fig. XXIV). The only other of such hermaphrodite type are the Minahasa one and a related design seen in Mindanao in the Philippines (Pl. V, fig. IX). Both agree in having the fore boom lashed directly to the float but in the Bali

variety there are no complicated accessory parts, the method of lashing being direct and simple; the fore boom, a squared strong pole, is practically straight; as a consequence the fore end of the bamboo float is raised high and thus offers less resistance when sailing. In the case of the aft boom, there is a very slight curve and this, as in the case of the Minahasa outrigger, is reversed, the ends bending upwards slightly. These are shaped as depicted in figure 54, and each has an oblique slot in the deeper part; through this the upper end of a short straight obliquely-placed stanchion is

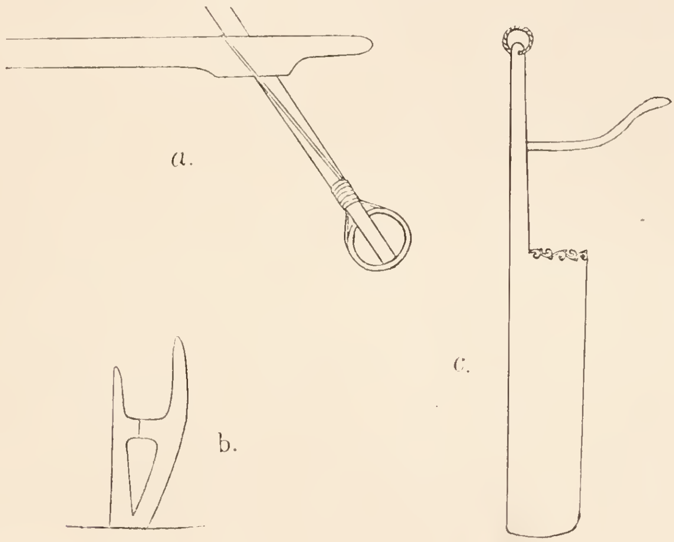


FIG. 54.—Details of a rare form of small Buleleng outrigger canoe seen in Bali; *a.* method of attaching the boom to the float; *b.* quarter-rudder crutch and pin; *c.* quarter rudder.

passed; the lower end is thinned somewhat and inserted in an oblique hole in the bamboo float. To secure the float, the same plan is adopted as in the large Buleleng outriggers—a cord being passed round the projecting peg-like top of the stanchion and carried down to be lashed around the float. A triangular sail carried by a stumpy mast is the rig; the same as in the large Bali type above described (page 96). Upon a Y-shaped rudder crutch of distinctive pattern, having one short vertical and a longer slightly curved limb, a quarter rudder of the usual prau form is hung from the bent arm. A slender and much longer crutch whereon to rest the mast when not in use, is placed right in the stern, abaft the other.

It is interesting to note that the ordinary type of small trader used on the Bali coasts is that of plank-built boats without outriggers, of the same general design but of much greater relative beam than the Bali type of outrigger canoe. It is clear that these have been evolved directly from the latter, increase in beam giving sufficient stability without recourse to the use of a clumsy outrigger.

MADURA.

What may justly be called the Madura type of double outrigger is used in large numbers by the fishermen of Madura. It is one of the strangest and most fantastic looking craft in the world, so strange as to be grotesque. In varying extremely from more ordinary and regular forms, it seems to occupy much the same position to them as did the fantastic ammonities of the chalk to their more staid predecessors.

The hulls of these canoes are dugouts with high and quaintly shaped blade-like bow and stern (Pl. XIV, fig. XXVI); a deep wash strake is added and several small pieces go to form the curious ends. The aft boom is in five pieces, a median stout cylindrical bar laid transverse across the hull, a broad wingshaped upwardly turned primary joint on each side and a downwardly curved secondary joint fitting into the primary at one end and into the float on the other. The details are shown in the figure. The median part projects but little beyond the gunwale on each side; the wing-like primary joint fits into it by its lower end, whittled down enough to enter the hole bored in the end of the cross-piece. Similarly the secondary is inserted by a peg-like extremity into the primary at a point midway along its outer edge; from here it curves downwards and outwards to be pegged into the float.

The fore boom is without the wing-like joint; the single joint present is a weak reversed curve; one extremity is inserted in the end of the median cross bar, all that remains of the boom proper, the other, bent up slightly, is lashed to the upper side of the float. The whole design is made up of a medley of curves, the float itself being bent in a deep curve, the concavity upwards. The floats are long bamboos, strongly curved upwards at the fore ends.

The great wing-joint of the aft boom is usually richly ornamented with carved designs—the one piece of decoration attempted A quarter rudder is used, hung from the usual crutch arm.

The rig is equally curious with the other features; the mast, a slender pole, is stepped aft at the fore side of the centre of the aft boom-thwart; it inclines slightly forwards and carries a long triangular sail, laced to a bamboo pole on each long side. The apex where the two poles meet, is secured right in the bows. The resemblance to the sails of the New Guinea *latakoi* is marked.

EAST JAVA.

By far the finest of outrigger coasting craft in the Dutch Indies are to be seen in the harbours of this region. These boats are fast disappearing; comparatively few exist and it is only at small oldworld ports such as Grisee, near Sourabaya in East Java, that they may occasionally be found. Two varieties are seen; the larger and rarer have a hull similar to that of the small bifid-prowed coasters and passenger praus that ply in crowds out of every harbour in East Java and Madura with bow obliquely truncate and gaudily painted on the flat foreside; the smaller have a plain hull with sharp bow and stern modelled upon the design of the ordinary fishing boat of the district (Pl. XV, fig. XXVII).

The larger of these outrigger coasters (Pl. XV, fig. XXVIII), shares with the tripod-masted prau of Macassar the distinction of being one of the two most distinctive and interesting craft in Indonesia. The former is clearly the immediate predecessor of the ordinary Javanese small coaster, the main change being the elimination of the outrigger. The hulls of both boats are carvel built, with numerous cross beams which pass through the planking to the outside, where the ends project about an inch and are picked out in black or other dark colour upon the lighter ground tint of the planking. The keel, instead of passing at each end into the stem and stern posts, is carried in a gentle upward curve forward and aft as the case may be, to end in a blunt ram-like projection just submerged when the boat is fully laden. The true stem is truncate somewhat as in Chinese sampans and like them is gaudily painted (Pl. XVI, fig. XXIX); no special convention controls the designs; many bespeak considerable decorative skill obviously influenced in numerous cases by European contact, as shown by the frequent employment of flags and national emblems. Ornamental scrolls symmetrically disposed, with conventional floral designs predominate. The form and general decoration of the stern agree generally with the bow but it is less prominent and high. A powerful

quarter rudder is used as is usual in these seas upon each quarter, hung when in use from a great rudder crutch or gallows close to the stern. There is no deck, the cargo being protected by moveable bamboo penthouse covers.

The outrigger frame on each side consists of two extremely stout booms attached to a compound float, usually of two bamboos of the largest available thickness. The booms are not laid upon the gunwale of the hull in the usual manner, but pass through the planking just above the water-line at full load. Each is thickest where it issues horizontally from the hull. From a point about 2½ feet outboard it raises in a gentle curve to mid distance, when it bends down at a similar gentle curve to meet the float. The forward boom is attached above the two float bamboos ; the aft one is pointed and inserted into the outer bamboo and above the inner one. On each side a light bamboo platform, two feet wide, is laid on longitudinal bamboos resting upon the hither portions of the two booms and upon the outboard ends of several thwarts projecting beyond the gunwale. These platforms provide the crew with accommodation to sit or stand when rowing and poling ; at each end of the port platform is fitted an elaborately carved and painted unequal-armed crutch for the mast and yard.

The rig differs entirely from that affected by the local praus without outriggers ; instead of their two short masts carrying triangular sails, point downwards, it consists of a single fairly tall mast hoisting a sprit sail, together with a long slender jibboom and small jib.

From certain of the details of this curious survival, conjoined with others drawn from the tripod-masted rig and open bulwarks of the deep-sea Bugi trading schooner of Macassar, from the oblong sail plan often seen in the fishing boats of the Moluccas and the Celebes, satisfactory understanding of the strange ships sculptured on the panels of the lower galleries of the Boro-Budur ruins in Java becomes possible. These sculptures dating from the 8th and 9th centuries of our era, undoubtedly represent outrigger sea-going vessels of greater size than any surviving at the present day. They stand for Javanese vessels furnished with very massive outriggers, double masts, and twin quarter rudders. In view of the fact that the *double* outrigger is used solely in the Malay Archipelago for all medium and large-sized outrigger boats and for the great majority even of small ones, the inference that the

ancient Javanese outrigger ships were similarly equipped is justifiable. In the smaller of the sculptured craft, a quarter steering paddle is clearly seen, and it seems certain that in the larger, the further development had been reached of placing them in a rudder trunk on each quarter; in this case, as in that of the large Macassar schooner-praus, the steersmen would sit in the quarters on the main deck beneath the poop deck; in the latter there is no rudder trunk, the tiller of each rudder passing through a large square port in the quarter of its respective side, the rudder being suspended outside from a gallery-like framework. In these modern vessels both the fore and main masts are of tripod pattern, consisting of an aft part of two nearly perpendicular spars inclined just enough to meet at the cross trees, the forward or unpaired leg with its apex inclined aft, to be inserted and secured by a pin just beneath the junction of the paired legs. In the Boro Budur ships the masts appear to be double, and in the restoration which I have attempted (Frontispiece), they are shown thus. The present day river barges of the Irrawaddi possess double masts braced with many rungs; this plan, I believe, was that used in the 9th century in Java. If this be so, the tripod mast, undoubtedly an improvement, must be a subsequent evolution. As for the oblong sails with a spar along each long side, seen in the Boro Budur ships, this is the ordinary sail of the majority of small craft on the Celebes coast and is often to be seen in the larger fishing boats working out of North Java ports. The hull of the Boro Budur boat remains; this has been described as a kind of basket work * but to any one who has seen the Macassar trading praus (Pl. XVI, fig. XXX) as well as the large outrigger coasters just described and those in use at Donggala in the Celebes, it is clear that the curious open timber work is an outboard superstructure reared on cross beams laid athwart the much narrower hull proper, to give greater passenger accommodation. The reason for not making it solid is to reduce weight and so to lessen the danger that accrues from heavy top-hamper. It is clear that an outrigger—a double one presumably for the reason already stated—becomes a necessity in the case of such a lofty and overhanging superstructure; without a safeguard of this nature the danger of capsizing would amount to a certainty in even a light breeze. The large Bugi schooner-praus show a vestige of this structure in the overhanging poop and the

* Schoff, W. H., *The Periplus of the Erythræan Sea* (translation). London, 1912.

high open bulwarks (Pl. XVI, fig. XXX), while the rudder-trunk cover on each quarter of the Boro Budur ships lingers in the open framework within which the quarter rudder is hung.

In south-east Java, at Banjuwangi, the Bali type of outrigger is met with as might reasonably be expected; generally of small size (Pl. XIII, fig. XXV). These show the bifid bow which in Bali is restricted to the largest sized outrigger. For their size the Banjuwangi canoes carry a big sail, of the oblong pattern; the mast is longer than is usual in the Bali type, and the yard instead of being hung from a peg at the top is hoisted by a rope to the masthead. The peg however persists, transformed into an ornamental finial. A single quarter rudder is employed.

JAVA—NORTH COAST.

An abnormal design of single outrigger, one which I believe must be a degenerate form of a type originally furnished with double outriggers, is common among the Javanese fisherfolk of the central region of the North Java coast. The distribution extends roughly from Cheribon to the neighbourhood of Rembang in the east. The hull is a long narrow dugout sometimes large enough to carry as many as 13 men; others are quite small; their use is confined almost entirely to inshore fishing, deep-sea work being carried on by built boats without outriggers. The hull is quite plain, a simple slabsided dugout with sharp and nearly vertical ends. The outrigger frame is reduced to a minimum. In the great majority it consists of a single bamboo boom laid athwart the fore end of the dugout; the weather end projects several feet, and is attached to the fore end of the single float, by means of a broad vertical stanchion shaped from a short length of plank. The outer end of the boom is passed through a hole in the upper part and secured by the insertion of a wooden pin or key thrust into it on the outer side of the stanchion (Fig. 55). The lower part of the latter is narrower than the upper, and is socketed into a slot cut in the upper surface of the bamboo float. Occasionally a second or after-boom is used, attached in the same manner to the float. When the canoe has to tack, the device is practised of shifting the outrigger to the opposite side in order that it may continue to be a satisfactory weather counterpoise—the same device is known and practised in India among the outrigger fishermen of the north-east coast of the Gulf of Mannar. A further point of interest is the fact that a form of

outrigger essentially similar in the way the booms are attached to the float, is found in Madagascar and on the Swahili coast of East Africa. There however the outrigger frame is often double; it probably represents the original or archaic form of the present Javanese type, from which the present has been derived by degeneration.

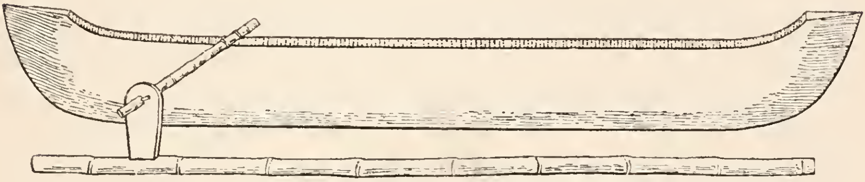


FIG. 55.—Small fishing outrigger dugout, north coast of Java.

Local names for these peculiar Javanese outriggers are: *Tjemplon* (Chemplon) and *Tembon* at Samarang and Cheribon, respectively.

SUMATRA.

On the east coast no indigenous outrigger canoes are now employed. Formerly and not at any remote date they appear to have been used throughout this island, for the Achinese of the 17th century, then a powerful people, employed the double form. Dampier gives an interesting account of the construction by Achinese sailors of a double outrigger in the Nicobar Islands; in this craft Dampier and these men escaped from the islands and arrived safely in Achinese territory. He lays stress on the value of the double outrigger in preventing the capsize of their canoe in the stormy weather they experienced on the voyage.

At the present day double outriggers are still to be seen at Padang on the west coast, and outrigger canoes are also found in the off-coast islands of this neighbourhood. The Padang canoes have two booms, connected directly with a float on each side.

According to Rappard* the inhabitants of the so-called Malay settlements on Nias use double outrigger canoes besides other craft. The same author states that the only seafaring section of the original population of Nias, viz., the population of Mazingõ (South-east Nias), also use trading canoes fitted with outriggers, in this

* Rappard, Th. C., "Het eiland Nias en zijne bewoners," *Bijdragen tot de Taal-Land-en Volkenkunde van Nederlandsch-Indie*, 7e Volgreeks, 8e deel, 1009, 's Gravenhage.

contradicting Modigliani's statement, quoted by Haddon,* of the absence of such craft from these islands. C. Chun † gives a photograph of a double outrigger from South Pagei, and the Raffles Museum in Singapore has a model of another from the Engano Islands of similar construction—a double outrigger frame and direct attachment. The most interesting item however, in regard to Sumatran outriggers is Rosenberg's statement ‡ that the Mentawei Islanders use the single outrigger, a fact of the utmost significance when we recall his opinion that the Mentawei people exhibit distinct Polynesian physical characteristics.

All these Sumatran outriggers appear to have direct attachment, whether they be single or double in form.

CONCLUSIONS.

The outstanding fact made clear by the foregoing study is the universality of the use of the double outrigger among Indonesian peoples. Further than this it is necessary to lay stress upon the fact that the double outrigger design is confined strictly to Indonesia with the exception of Madagascar, the Comoro islands and the Swahili coast of East Africa.§ The conclusion is therefore logical and reasonable that the invention of the double outrigger should be credited to the intelligence of the ancestors of the present Indonesians.

In this connexion arises the difficulty of determining whether the single or double outrigger is the original or more primitive form. We have seen how the double outrigger is associated most strictly with the Indonesian peoples—those tribes and race sections who have distinct Mongolian affinities and whose true relationship would be better expressed by the term Malaysian, the Malays being in some ways the best developed as well as the most widely spread section of the communities occupying this region. Wherever people of Indonesian origin have penetrated, there the double outrigger is seen unless replaced by craft other than outrigger canoes—the adventurers who crossed the Indian Ocean to Madagascar took it

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* Haddon, A. C., "The Outrigger Canoes of Torres Straits and N. Queensland," in *Essays and Studies presented to W. Ridgeway*, Cambridge 1913.

† Chun, C., *Aus den Tiefen des Welt meeres* (Valdivia Expedition).

‡ Rosenberg, H. von, *Int. Archiv f. Ethnogr.*, I, 1888.

§ For notes upon the double canoes of this outside region, see Haddon, A. C., *Man*, 1918, 29, and Hornell, J., *Man*, 1919, 55 and *Man*, 1920, 67.

with them and now it has passed to the East African coast. In the same way we find it in use in the Philippine Islands, particularly among the Moros trading and smuggling between the southern islands and British North Borneo. Southwards it extends to Java, Bali and the neighbouring islands and eastwards to Western New Guinea. Only in the west of the Archipelago—on the east coast of the island of Sumatra—do we find it absent, being there replaced by boats without outriggers. (This exception appears to be a consequence of the strong influence exercised upon Sumatra by the Arabs who have never used nor understood the outrigger.)

With regard to the single outrigger, apart from South India and Ceylon, the Andamans and the Nicobars, the only peoples using it consistently as their dominant boat type are the Papuasians and the Polynesians, to whom, with the exception of the Papuans of North-West New Guinea, the double outrigger is as foreign as the single is to the Indonesians. Taken generally the present-day far eastern distribution of the single outrigger is confined to the race distribution of the Papuasians, Polynesians and Micronesians. Except in North-West New Guinea there is no overlapping of the two types. Structurally and from the nautical standpoint, the small single outrigger represents a stronger and more handy craft than the double one of the same size, especially when running before the wind, but it suffers from the fatal defect of being unable to beat to windward except at great risk of capsize, unless most unsailorlike means be resorted to. Of the methods evolved to meet this difficulty, the most common is that of having the hull double-ended, with the mast in the centre, and stem and stern interchangeable according to what tack the canoe is on. This has been adopted in Ceylon. A second, evolved only in North Java and on one short stretch of the Indian coast, is to shift the outrigger frame from side to side as required by the wind; this device allows the canoe to have a permanent stern and steering gear always at the same end. In large outrigger craft too big for either device to be adopted, such vessels, of which the two-masted Sinhalese outrigger coasters, running to 30 tons burden, are the best surviving example, we find these vessels can be employed only during the fine weather season of the year, when winds are light and are often in the nature of land and sea breezes. These boats creep along the coast never venturing far

from land, and working so with the local breezes that it is seldom the outrigger is on the lee side. With a light wind prevailing, this is not dangerous to such a comparatively large vessel well loaded with cargo.

In this connexion I must not omit to point out the probability that outrigger vessels of larger size than any now existing, were the ordinary sea-going craft of Java over 1,000 years ago. Indeed it is in Java that the largest outrigger coasting vessels anywhere outside of Ceylon have survived to our own times. Unfortunately we cannot as yet be quite certain whether these old Javanese outrigger ships were provided with the single or the double form ; the persistence of the double form in the existing Javanese coasters is a strong *a priori* reason for the belief that they had the double rig. In respect of ability to beat to windward, the double outrigger is a decided advance upon the single ; it possesses the further advantage that it permits of very roomy cabin structures being built ; the lateral parts may project several feet outboard on either side, resting upon the projecting ends of stout thwartship beams, as in the Boro Budur ship design ; this has the advantage of permitting the immersed portion of the hull to be small in sectional dimensions, offering a minimum of resistence in its passage through the water. Under adverse conditions the single outrigger behaves well if carefully and strongly constructed, but it is not good in fine weather for long voyages, even when the winds are regular and seasonal, on acccunt of inadequate cabin accommodation ; in eastern seas long voyages can usually be taken in perfect confidence that the wind will remain in the same quarter for the whole duration of the trip.

Whether or not we accept the conclusion which I put forward that the double outrigger was evolved from the single form it is unthinkable that they had separate or independent origin.

The conclusion that the single outrigger is the primitive type, from which the double was derived in consequence of the necessity found by some of the users of the single form for one better adapted for commercial purposes, and the prosecution of long voyages, receives its greatest confirmation from the present distribution of the single outrigger. Only on such a hypothesis as the above can we account satisfactorily for the striking discontinuity in the geographical range of this type. There must have been a time when its range extended from India and Ceylon to hither

Polynesia, a time prior to the invention of the double type. Neither Dravidian Indians, Polynesians, Micronesians nor Papuasians (save a few borderland Papuans) exhibit any knowledge of this latter type—not the slightest trace that it was ever used in these regions can be found. The Mongoloid inhabitants of the Malay Archipelago—the Indonesians of most writers—are admittedly later comers into the Archipelago: we have definite proof that many of the eastern islands of Indonesia were at one time peopled by Papuasians—their blood persists. The Mongoloid incomers undoubtedly came from the Asiatic mainland *viâ* the Indo-Chinese peninsula. These people, more industrious and more enterprising than either the Polynesians or the Papuasians, appear to have rapidly displaced the older races, Polynesians in the hither islands near the Asiatic coast, Papuasians in the outer groups towards the south-east. In the course of this notable race migration the idea of the outrigger canoe was seized upon—probably the new comers were little acquainted with boat-building other than of dugouts. As the Mongoloids advanced and throve, the first to be pushed aside would be the Polynesians; the impact of conquering hordes upon a weak and scattered people—the Polynesian tribes never seem to have understood the value of cohesion—would drive the more independent spirits to a new migration. Some appears to have passed to India and Ceylon, others took refuge in the islands off the west coast of Sumatra—among their descendants being the Mentawei islanders who still use the Polynesian single outrigger; the bulk, other than those absorbed by the invaders, appear to have gone east to the myriad isles of the Pacific.

Settled in what we now term Indonesia, the early Malaysians throve and multiplied, more especially in Java, where at a very early date they came under the civilizing influence of Indian missionaries—whether the first were Buddhist or Brahman it is now impossible to say. Prior to that date, the Malaysians must have improved upon the single outrigger type employed by the Polynesians and Papuasians, converting it into the more commercially serviceable double form. This type probably reached its zenith during the heyday of Buddhist influence, for I feel sure that all the outrigger ships sculptured in the great Buddhist shrine of Boro Budur, built during the 8th and 9th centuries, must have been furnished with the double type. Their lineal descendants seem to have divided into two sections, the one retaining the double

outrigger device exemplified in the few small outrigger coasters lingering to extinction in east Java, and the other, a very vigorous and healthy branch, represented by the great tripod-masted trading praus of the Bugis of the Celebes. These are to be seen by the score any day in Macassar harbour; the compound masts, great poop, high open bulwarks and double quarter-rudders of their prototype have been preserved but the whole outrigger device has been discarded, concurrently with a great development—broadening—of the underwater portion of the hull.

In regard to details and the variations of the double outrigger found within Indonesia itself, the types most widely spread are the direct and that which I have termed the East Indonesian. The latter stretches in an unbroken chain from Lombok, north to the Celebes, thence east to the Moluccas and on to N.-W. New Guinea. Only in Sumatra, Java, Madura and Bali, the islands most intimately influenced by Indian thought and enterprise, is this type absent; the sculptures of Boro Budur though not so clear as one would desire, lend support to the idea that a thousand years ago the same design was indeed current in Java, and used for very much larger craft than any of the present day. This great extension in time as also in geographical range would seem to indicate that *this is the central and most characteristic of true Indonesian designs*; that all others save the direct are local variations evolved either by local ingenuity, usually to meet special and limited requirements, or else copies or adaptations of designs in use by people of other races, Papuasian or Polynesian, who use single outriggers.

With regard to the direct form of outrigger, where the booms are lashed to the floats without any intermediate joint, present-day distribution is curiously discontinuous, for this type is found only on the west coast of Sumatra and in the Philippines, the Sulu Islands and, both in the pure form and in one most curiously hermaphrodite, in Minahasa (N. Celebes) and the Sangir islands to the north. Apart from the simple form of direct connexion seen commonly in Minahasa, it is quite clear that the hermaphrodite type found in the same region marks the meeting place of two distinct types; in its bifid ends, the use of braces to stiffen the booms, and especially in the direct connexion of the forward boom with the floats, the resemblances of the Minahasa design with that of Sulu are perfectly clear, while the use of the East Indonesian type of

connexion in the case of the aft-boom indicates its close relationship to this type which elsewhere in the Celebes and the Moluccas is the dominant design. The resemblances of the Minahasa design with those of Sulu and Mindanao are much greater than those indicating kinship with the other origin, and there can be no doubt that this design originally came from the Philippines *viâ* the Sangir islands and that it has since been modified by contact with the East Indonesian design. But whence came the Sulu and the Philippine designs? We know of no other related instances of direct attachment, apart from Minahasa, except upon the west coast of Sumatra. Considering the distance between Sumatra and the Philippines, any close connexion would seem most unlikely. But the coast people of Sumatra have been great voyagers and curiously enough Sulu-Moro tradition claims for their aristocracy a direct lineage from the nobles of the Achin tribes inhabiting the northern part of Sumatra. I must mention that Colonel Waloe, who communicated this tradition to me, was then ignorant that direct attachment of boom to float is a characteristic feature shared alike by the outrigger canoes of Sumatra and the Sulu islands.

The form and ornamentation of the stern in Sulu outriggers has a significantly close resemblance to designs seen in N.-W. New Guinea; Papuasian influence is therefore indicated. Similarly there is a distinct resemblance between the curious bow of the Sulu canoes and that of East Javanese 'sampans' and outrigger coasters; all alike are characterised by the bifid form of stem and stern. There is also a close approach to the direct type of boom and float connexion seen in East Javanese outrigger-coasters that is suggestive. Probably these also derived from a common source with those of the west coast of Sumatra.

Instances of purely local variations are those in use in the Minahasa and in Būton and Raha (S. Celebes); the latter are obviously based on the normal form of the East Indonesian type.

To the class derived ultimately from Papuasian and Polynesian sources, belong, I believe, both the Java type, and those of Amboina and Buru. The former is particularly interesting for it is, with the exception of the Mentawei outriggers, the only type of Indonesian outrigger that is invariably single—those of Macassar constitute obviously a mere variation from a local double form. But howsoever interesting this may be, it sinks into

insignificance compared with two other facts. Of these the first is that outrigger canoes of essentially the same design but often with double frames instead of single are employed in Madagascar, and on the East Coast of Africa; the second, that in the Marquesas islands a single outrigger of almost identical construction is used commonly for inshore fishing.* As I suggest below, the general inference from the far eastern distribution of the different types of outrigger canoes and their present-day builders, tends to show that at one time the Polynesian users of the single outrigger were distributed throughout Indonesia, that the incursions of Mongoloid people—the main stock from which the present Indonesians are derived—displaced the Polynesians and drove them afield both east and west. It may well have happened that the Marquesan type referred to above, wherein the stanchion connexion between the booms and the float is on essentially the same design as that used in the North Java type, was in use by the aboriginal inhabitants of Java on the coming of the proto-Malaysians; that the dispossessed, some of whose descendants may be the Marquesans of to-day, carried the design with them in their wanderings, and that the incomers at the same time adopted the design and transmitted it with little change to the present inshore Javanese fishermen. It is very probable that in the days when the double outrigger design was dominant in Indonesia for the largest craft as well as for small dugouts, that the larger boats using the North Java design employed it in the double condition; in this stage, I believe, it must have been when one or other of the waves of Malaysian emigration struck the shores of Madagascar, and introduced it there. As the Malagasy languages even in the case of the latest arrivals, in regard to the inclusion of Sanskrit words, are purer and in a more archaic condition than either Malay or Javanese, although otherwise closely related thereto, we are able to date back the time of the use of the present North Java type in its own country to a period anterior to the date of the first Buddhist or Brahman missionary influence in Java, i.e., to a time prior to the Christian era. It is very probable that both the double and the single form of this type were in use concurrently in Java, just as we find both forms in use in

* Alexander, A. B., "Notes on the Boats, Apparatus, and Fishing Methods employed by the natives of the South Sea Islands," *Report of the U.S. Fish Commissioner for 1901*, Washington, 1902, p. 745.

Madagascar at the present day. With the gradual abandonment of the outrigger form that appears to have been in progress in Java during recent centuries—possibly since the advent of dominant Muhammadan (Arab) influence—this outrigger type has gradually degenerated. The double form, most suitable for deep-sea work, has been entirely superseded by the weatherly Malay *kolek* or *majang*, whilst the single form, possibly retained in use from the earliest times for inshore fishing has so deteriorated that two booms are now seldom used, the fore one only being retained in the majority of cases.

I am disposed to consider the Amboina loop and the Būrū U-type as derived from Polynesian and Papuasian types in which the secondary connecting booms and float is formed of several rod-shaped stanchions. At Humbolt's Bay in New Guinea, two pairs of stanchions placed obliquely in such manner as to show a V-shaped outline when viewed from in front or from behind, form the connexion. If a V-shaped fork be substituted for separate rods placed obliquely or in U-fashion we get a variation closely approximating to the Ceram variety of the Buru type; the U-shaped joint would soon follow, as this form is clearly stronger and more easily lashed on than a sharp-angled V-joint. From the U joint to the Amboina loop or O-type is a short step in variation or evolution.

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EXPLANATION OF PLATES.

PLATE I (FRONTISPIECE).

Figure I.—Original restoration of a large Javanese two-masted outrigger vessel of the 8th or 9th century A.D. From a sculptured panel at Boro Budur, Java.

PLATE II.

Figure II.—Two double outrigger canoes, Manokwari, Geelvink Bay, Papua. One has 8 and the other 5 booms. In the background is a small-size outrigger with 5 booms. The foremost canoe has a washboard of 5 vertical rows of palm leaf-stalks surmounted by a narrow gunwale of soft wood.

" III.—One of the largest Manokwari outrigger canoes in process of having the outrigger frame put together. The prow ornament is an elaborate piece of pierced carving.

PLATE III.

Figure IV.—Another Manokwari double outrigger with prow of another pattern.

" V.—A small-sized double outrigger fishing canoe of the Geelvink Bay type; seen at Humbolt's Bay.

PLATE IV.

Figure VI.—Waigou type of double outrigger at Saonek, N.-W. Papua.

" VII.—Double canoes with direct attachment, Jolo, Philippine Islands.

PLATE V.

Figure VIII.—Large two-masted outrigger-coasters, with direct attachment, Mambajao, Camiguin Island, Misamis Province, Philippine Islands.

" IX.—Double outrigger canoe, with hermaphrodite attachment (closely related to the Minahasa type), Las Palmas, Mindanao.

PLATE VI.

Figure X.—Two large Moro vintas, Mindanao.

" XI.—Small Moro vinta seen from aft, to show the bracing of the aft boom, etc.

PLATE VII.

Figure XII.—View, looking forward, of the inside of the hull of the Moro vinta shown in fig. XI.

" XIII.—Details of boom braces and their attachment to the booms in the same Moro vinta. Note the carved ends of the braces.

PLATE VIII.

Figure XIV.—Carved stern of a Moro vinta.

" XV.—Fishing canoe of East Indonesian, type Menado, Celebes.

PLATE IX.

Figure XVI.—Small Coaster of East Indonesian type, Menado, Celebes. Three booms present. The cargo is loaded upon a rough platform of poles laid across these booms.

" XVII.—Minahasa type of fishing outrigger, Menado, Celebes.

PLATE X.

Figure XVIII.—Double outrigger canoe with sub-direct attachment. A low chock is intercalated between the float and the end of each boom. Macassar.

" XIX.—A single outrigger canoe of a type common at Macassar; each boom has a downwardly bent distal portion attaching directly to the float. A conspicuous crutch at the stern. Tripod-masted praus in the background.

PLATE XI.

Figure XX.—A small river canoe of single outrigger type, Macassar. It has direct attachment and small as it is, has a quarter rudder and rudder crutch.

" XXI.—Double outrigger, Lombok type, Labuan Hadji, Lombok.

PLATE XII.

Figure XXII.—Small fishing double outrigger of the Bali type, Labuan Hadji, Lombok.

„ XXIII.—Large outrigger, Bali type, Buleleng, Bali. View from aft.

PLATE XIII.

Figure XXIV.—Three Bali outriggers. The one in the foreground with the sail up is a small one of the Bali hermaphrodite type.

„ XXV.—A Bali type of fishing outrigger Banjuwangi, East Java.

PLATE XIV.

Figure XXVI.—Fishing outriggers, Madura.

PLATE XV.

Figure XXVII.—Medium-sized outrigger coaster, Grisee harbour, East Java.

„ XXVIII.—East Java outrigger coaster of the largest size, now very rare.

PLATE XVI.

Figure XXIX.—Prow of a Madura *Kolek*, or 'Sampan' to show the bifid form of bow, and handsome ornamentation. These have no outriggers; they have been derived from the type shown in figure xxviii.

„ XXX.—Macassar trading prau. Note the tripod masts, the open bulwark framing and the built out structure around the stern.

All photographed by J. Hornell, except Nos. XXV and XXVI (Kurkdjian, Sourabaya), XXVII and XXVIII (Hermann, Sourabaya), and Nos. VII—X, and XI—XIV, which I owe to the courtesy of the Bureau of Science, Manilla, and of Col. O. C. Waloe, U.S. Army, respectively.

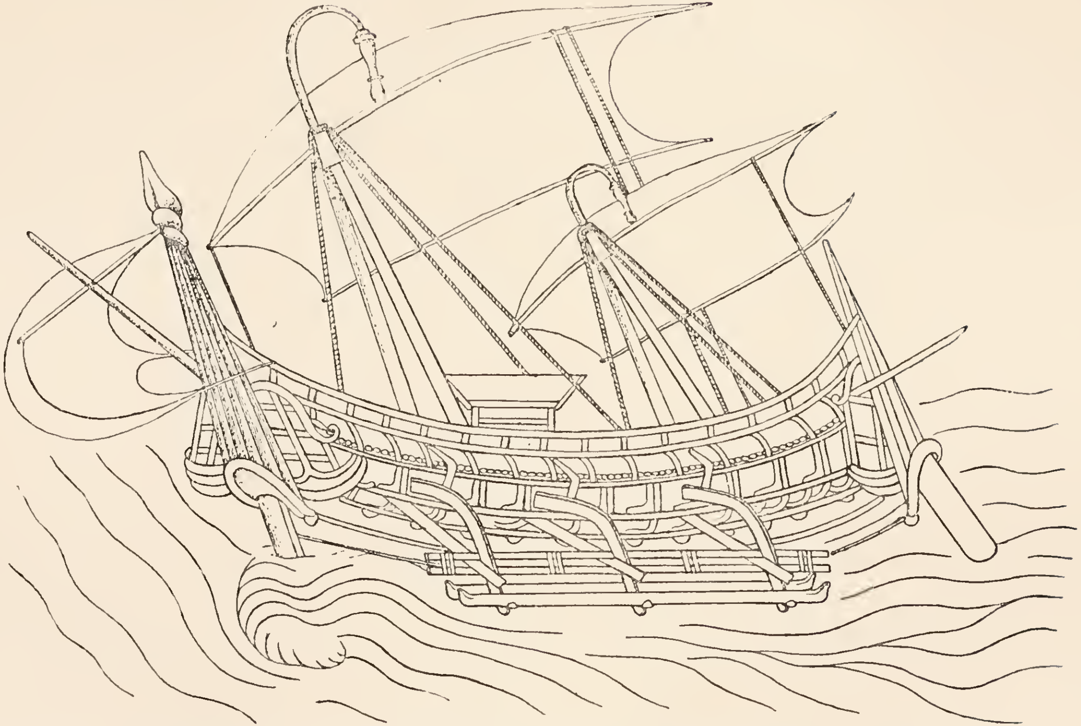

FIG. I.—RESTORATION OF A LARGE JAVANESE TWO-MASTED OUTRIGGER VESSEL OF THE 8TH OR 9TH CENTURY A.D. FROM A SCULPTURED PANEL AT BORO BUDUR, JAVA. (ORIGINAL.)

FIG. II.—TWO DOUBLE OUTRIGGER CANOES, MANOKWARI, PAPUA.

FIG. III.—A LARGE OUTRIGGER CANOE, BEING FITTED OUT FOR SEA, MANOKWARI, PAPUA.

FIG. IV.—A LARGE MANOKWARI OUTRIGGER CANOE WITH FINELY CARVED PROW.

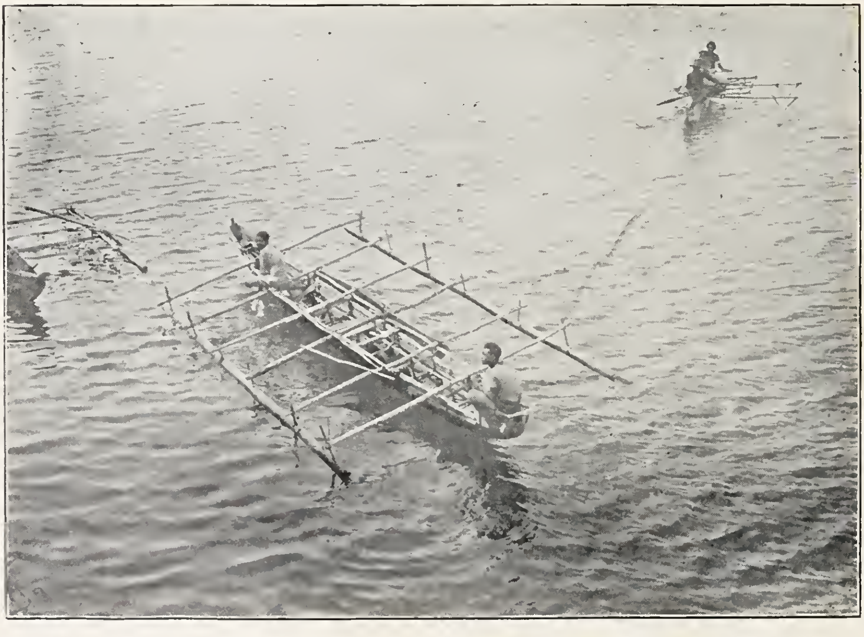

FIG. V.—A SMALL DOUBLE OUTRIGGER CANOE, GEELVINK BAY TYPE.

FIG. VI.—WAIGOU TYPE OF DOUBLE OUTRIGGER, SAONEK.

FIG. VII.—DOUBLE CANOES WITH DIRECT ATTACHMENT, JOLO, PHILIPPINE ISLANDS.

FIG. VIII.—TWO-MASTED OUTRIGGER COASTERS, MISAMIS PROVINCE, P.I.

FIG. IX.—DOUBLE OUTRIGGER OF HERMAPHRODITE TYPE, MINDANAO, P.I.

FIG. X.—TWO LARGE MORO VINTAS, MINDANAO.

FIG. XI.—SMALL MORO VINTA SEEN FROM AFT.

FIG. XIII.—DETAILS OF BOOM BRACES, ETC., IN SAME VINTA.

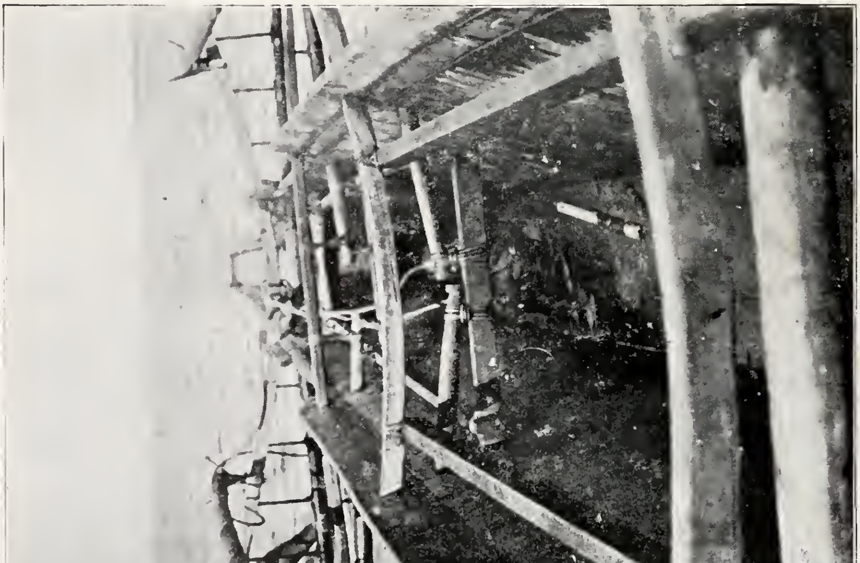

FIG. XII.—INSIDE OF HULL OF THE MORO VINTA SHOWN IN FIG. XI.

FIG. XIV.—CARVED STERN OF A MORO VINTA.

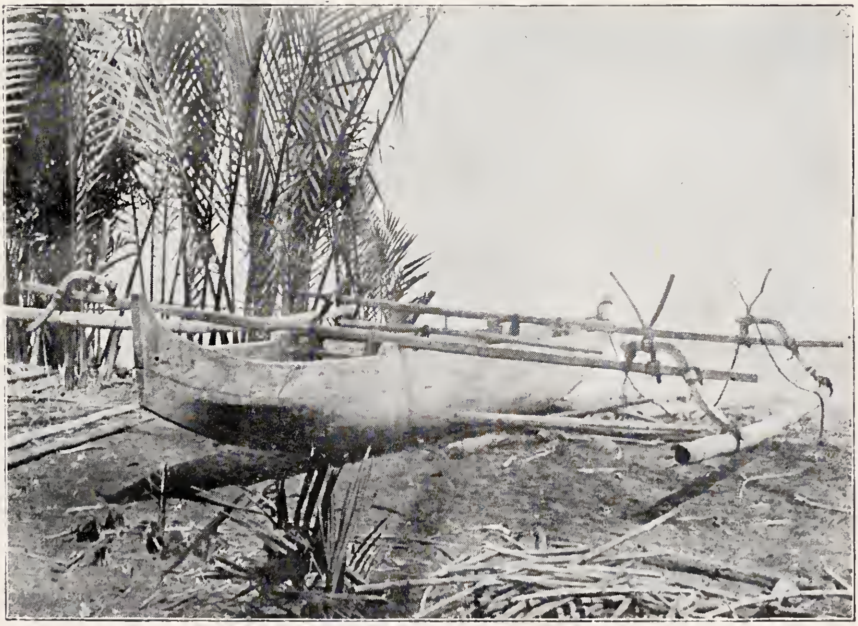

FIG. XV.—FISHING CANOE, E. INDONESIAN TYPE, MENADO.

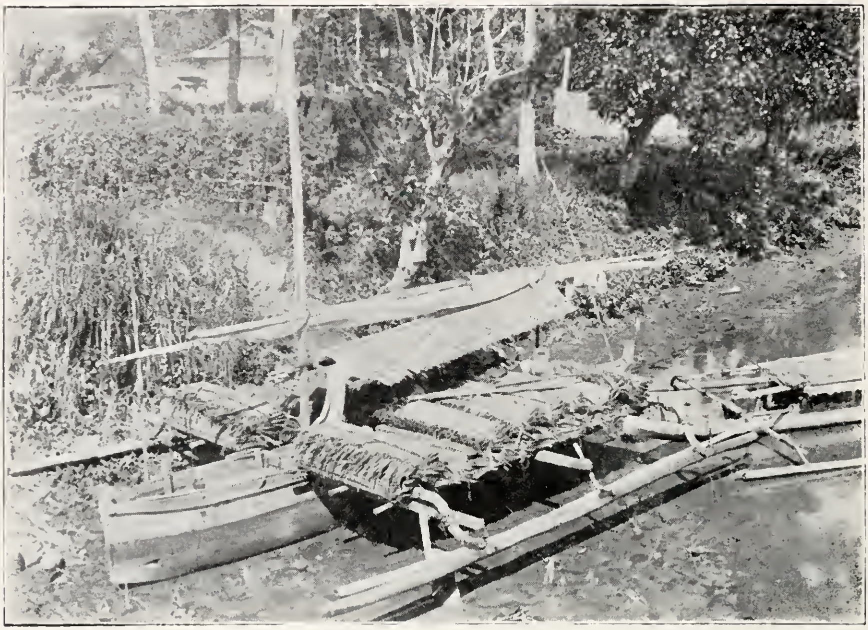

FIG. XVI.—SMALL COASTER, E. INDONESIAN TYPE, MENADO.

FIG. XVII.—MINAHASA TYPE OF FISHING CANOE, MENADO.

FIG. XVIII.—DOUBLE OUTRIGGER WITH SUB-DIRECT ATTACHMENT, MACASSAR.

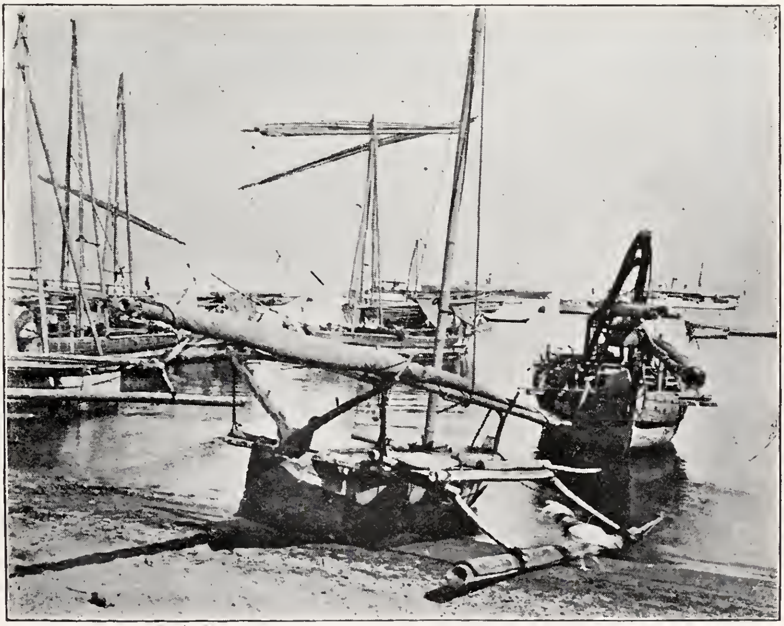

FIG. XIX.—A SINGLE OUTRIGGER FISHING CANOE MACASSAR.

Fig. XX.—A small River Canoe of Single Outrigger Type, Macassar.

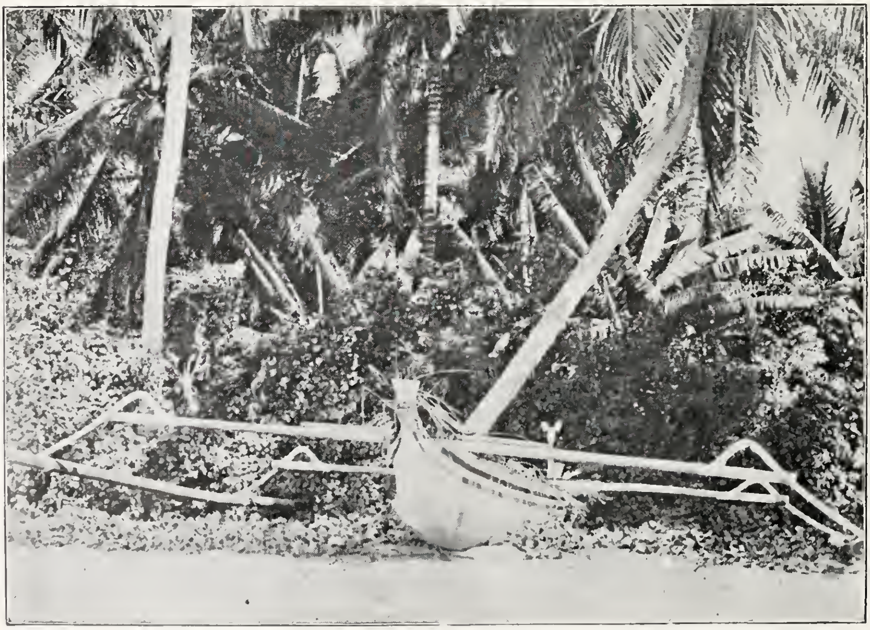

Fig. XXI.—Double Outrigger, Lombok Type.

FIG. XXII.—SMALL FISHING DOUBLE OUTRIGGER OF THE BALI TYPE, LOMBOK.

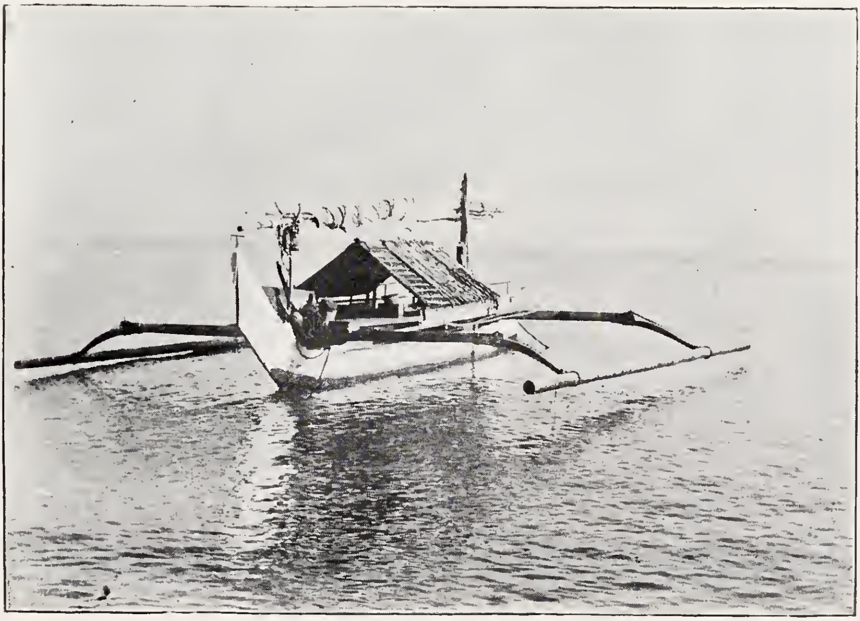

FIG. XXIII.—LARGE OUTRIGGER, BULELENG, BALI.

FIG. XXIV. THREE BALI OUTRIGGERS.

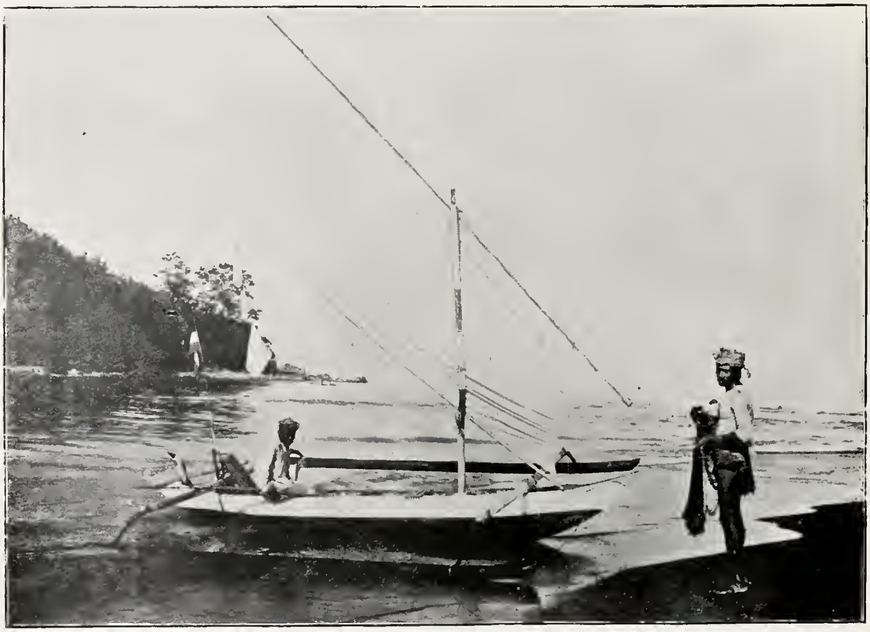

FIG. XXV. A BALI-TYPE FISHING OUTRIGGER, BANJUWANGI, E. JAVA.

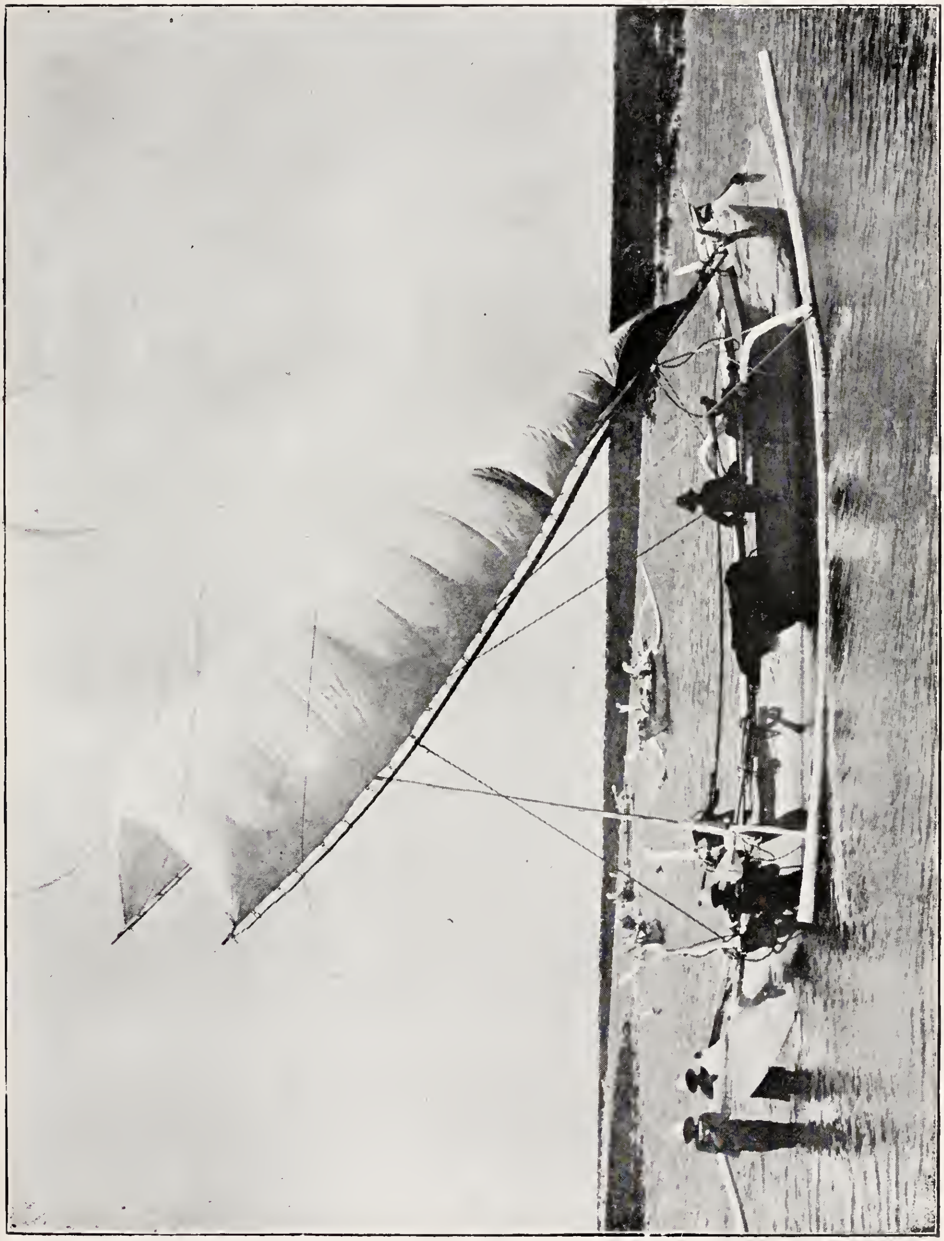

Fig. XXVI.—Fishing Outrigger, Madura Type

FIG. XXVII. OUTRIGGER COASTER, GRISEE, E. JAVA.

FIG. XXVIII.—LARGEST-SIZE OUTRIGGER COASTER, E. JAVA.

FIG. XXIX.—BIFID PROW OF A MADURA 'KOLEK.'

FIG. XXX.—A MACASSAR TRADING PRAU.

MALABAR CANOES HAULING AN ODAM VALA AT MADRAS.

Report No. 3 (1920).

A STATISTICAL ANALYSIS OF AN INSHORE FISHING EXPERIMENT AT MADRAS DURING 1919

BY

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Certain markedly distinct physical features of the East and West Coasts of our Presidency, affecting in their own way the nature of the fish catch, have given rise to the peculiar fishing craft and appliances characteristic of each coast. The muddy-bottomed, comparatively surfless region of the West Coast, rich with seasonal migratory shoaling fishes, such as sardines, mackerel, cat-fishes, ribbon-fish, prawns, soles, etc., and the predatory larger ones that are ever after these, has brought about the evolution of big, swift-moving, dug-out canoes and powerful seine, drift and cast nets and long lines, the last two being peculiar to that coast: whereas the generally sandy, surf-beaten East Coast has not gone farther than the primitive catamaran—a fishing raft made of a few (3—5 or even 7) logs of wood lashed together—with small sized seines, drift nets and hand-lines.

Though shoals as big as those of the West Coast are seldom, if ever, found on this coast, yet a few species do occur in small shoals at certain short seasons and the fishing craft and methods in vogue with the local fisher-folk at present are quite inadequate to a proper exploitation of the inshore fisheries. Though catamarans can pass through the most dangerous surf with immunity even during the height of the north-east monsoon when given sufficient driving power, in actuality the power available from the single primitive paddle and a couple or even five, small oars is insufficient to carry the keelless, flat raft across the surf line; further, the catamaran being of very small carrying capacity can admit of no heavy nets being employed from it. This state of affairs having attracted the attention of the Fisheries Department

sanction was obtained from the Government by G.O. Mis. No. 1477, Revenue, dated 24th May 1917, to conduct an Inshore Fishing Experiment with the Madras Harbour as its base, with a view (1) "to test the catching capacity of West Coast boats and nets as against the fishing capacity of the local catamaran" and (2) "if successful to introduce them among the Madras fisher-folk."

It was with considerable misgivings the experiment was commenced in June 1917 and continued till the close of May 1918. The results were not conclusive, so in order to give further opportunity to test the value of the new methods sanction was obtained (G.O. No. 3387, Revenue, dated 5th October 1918) to continue and extend the operations for a further period of 2½ years. Accordingly it was recommenced on the 16th December 1918 with four canoes (two small and two large) having a complement of 22 men as crew.

The following nets and lines were tried during the year 1919:—

Nets:—

1. Paithu Valā. 2. Vakku Valā.	Or Odam Valā.	(A large boat seine operated from two big canoes.)
3. Sulthān Valā ...	... ...	(Operated from two small canoes.)
4. Kolli Valā ...	... ...	(Operated from two big canoes.)
. Chāla Valā.	Gill-net	(Operated from one to four small canoes.)
6. Odu Valā and Kandādi Valā.	Drift-nets ...	(Operated from small canoes.)
7. Veechu Valā.	Cast-net ...	(Operated from one small canoe or from shore.)

Lines:—

8. Cheria Veppu.	Long-line with 1,000 hooks.	(Operated from one small canoe.)
9. Sravu Veppu.	Long-line with big shark hooks.	
10. Kai Chundai.	Hand-line ...	

A short note of all the above regarding their structure and operation is given below:—

The cost of a big canoe ranges from Rs. 200 to Rs. 800 (pre-war), and Rs. 250 to Rs. 1,000 (present rate), and that of a small one from Rs. 150 to Rs. 300 (pre-war) and Rs. 300 to Rs. 450 (present). Canoes are made from either Aynee (Malabar), Cheene, Punna, Pine or Mango-wood of which one made of Aynee is considered to be the strongest and hence the costliest. The big canoes are 28 to 34 feet long while the small ones are 12 to 15 feet long.

(1) *Paithu Valā.*—This is a large seine net operated from two big canoes. It appears in the following three forms, differing from each other only in the number and nature of the thread used and slightly in size:—

(*a*) *Naria Valā.*—This is a cotton seine with a wide mouth to which is attached a double armed, big meshed, coir rope net "Thattu," which serves only to frighten the fish into the bag net. The pre-war price of a Naria Valā was Rs. 100 to Rs. 150, the present price is about Rs. 225. The bag itself is 7 to 7½ fathoms long from the apex to the periphery and 25 fathoms along the latter. Roughly about 140 skeins of thread (numbers 10 and 20) will be required for making one Naria Valā. It is made up of several pieces with 50 meshes each. The apical part of the net is called "Vattam," the peripheral margin "Naria Valā" and the intervening part "Adi Valā." The number of net pieces and ply and the nature of the thread used in the various parts are given below:—

—	Number of net pieces used.	Number of meshes in one square inch.	Number of thread used.	Number of ply used.
Vattam	25	16	10	12
	20	16	10	10
Adi Valā	28	16	10	6—8
Naria Valā	35	9	20	5
	900 to 1,000	9	20	4

About 40 skeins of thread are required for Vattam and Adi Valā and 100 for Naria Valā. Along a fourth of the upper part

of the periphery (Mēvala) runs a thick coir rope to which are attached two big and three to nine smaller floats, the number of the latter depending on the depth required, while there is a thinner rope along the remaining three-fourths (Allu Valā), which connects the Thattu (coir net).

Thattu.—This coir net portion is also made up of three parts "Keezh Valā," "Kachu Valā" and "Kadangani" as below :—

1. Keezh Valā ... ... 50 cubits long.
2. Kachu Valā ... ... 55 do.
3. Kadangani ... ... 20 fathoms long.
4. Kamba (stout coir rope) ... ... 20 to 100 fathoms long.

The size of the meshes increases gradually from the commencement of Keezh Valā to the end of Kadangani as can be seen from the following table :—

	Size of mesh.	Number of meshes along the width.
Keezh Valā (for 15 cubits in length).	8 fingers (knot to knot).	50
Do.	10 do. ...	50
Keezh Valā (for 20 cubits in length).	12 do. ...	50
Kachu Valā for 55 cubits.	12 do. ...	45
Kadangani for 19 knots.	1 cubit	35
Do. 18 knots.	1½ do.	25
Do. 17 knots.	2 do.	20

There are two big floats and three small ones generally along Mēvala, ten small ones along each Kachu Valā and two along Kadangani while there are two and four weights along the lower line of Keezh Valā and Kadangani respectively. The price of one Naria Valā varies from Rs. 100 to Rs. 150 (pre-war) and Rs. 225 (present). Sardines, mackerel, prawns and other miscellaneous fish are caught with this.

(*b*) *Eda Valā or Anjezha Valā* (5 *ply net*).—This is similar to (*a*) in shape and dimensions but the number of ply used in the peripheral portion is more by one or two and more of No. 10 count

is used for a portion of the Naria Valā part also. About 200 skeins of thread will be required for one Eda Valā. Cat-fish and other medium sized fishes are caught with this net. The price of one net is Rs. 175 to Rs. 200 (pre-war) and Rs. 300 (present).

(*c*) *Vakku Valā.*—This is also similar to 'a' in shape, but it is a little bigger in size and is made of hemp; this is the biggest net in Malabar.

The price of one net is Rs. 200 to Rs. 300 (pre-war) and Rs. 350 to Rs. 450 (present). Shoals of big and powerful fishes, e.g., Kora, bigger cat-fish, etc., are caught with this net. To operate (*a*) and (*b*) the 2 big canoes are manned by 10 to 14 men, but to (*c*), 12 to 18 men are required.

(2) *Sulthan Valā.*—This is a smaller seine net operated from 2 small canoes with 3 to 4 men in each. In fact, it is a miniature Paithu Valā with the bottom of the purse extended far out of the mouth thus diminishing the width of the Keezh Valā of Thattu. The length of the purse from the apex to the periphery is 1 fathom less at the top and 7 to 8 fathoms more at the bottom than that of the Paithu Valā. Thattu (coir rope-net) of Sulthan Valā is made up of the same 3 parts, Keezh Valā, Kāchu Valā, and Kadangani and they are 15 cubits, 20 cubits and 15 fathoms long, respectively. The terminal coir rope (Kamba) is 10 fathoms longer than that of Paithu Valā. The meshes gradually become bigger towards the mouth as in (1) but they are here specially bigger near the thattu.

The cost of one net is Rs. 200 (pre-war) and Rs. 350 (present). The catches here consist of mackerel, sardines and other small fish.

(3) *Kolli Valā*—(means an instrument of destruction which it proves to be especially to Sardine shoals).—This is also a cotton seine similar to Sulthan Valā but double its dimensions. This is operated from 2 big canoes manned by 10 to 16 men. The cost of one net is Rs. 300 to Rs. 350 (pre-war) and Rs. 500 to Rs. 600 (present).

(4) *Veechu Valā* (*Cast net*).—This is a large circular net weighted rather heavily along the periphery. There is a ring at the apex through which passes a coir rope which is tied to a certain fixed number of strings each of which while radiating towards the peripheral string divides into 3 branches. Fishermen cannot operate the cast net without considerable practice over a number of years generally commencing from their boyhood. This net is

of many varieties differing according to the kind or size of fish intended to be caught. It is made of either cotton or hemp. It is operated from one small canoe with 3 to 4 men. The following are the varieties of cast net:—

(i) *Kara Valā* (cast from shore) or Thirutha Valā (Thirutha-mullet) made of hemp.

(ii) *Muttu Kanni Valā* (close meshed) for prawns—cotton or hemp.

(iii) *Kettum Valā* for sardines and mackerel—cotton or hemp.

(iv) *Churukku Valā* do. do. do.

(v) *Nethel Valā* for nethel fish (anchovy) this is the smallest meshed cast net, 1/12th inch square mesh.

(vi) *Narimin Valā.*—This is the biggest meshed cast net for Narimīn (Lates), 4-5 inches square mesh.

Unlike other nets described hitherto the cast net is made of one single piece, 7 to 14 cubits long, from the apex to the periphery: the weights used are of bronze, iron or lead weighing 8 to 24 lb. The cost of the cast net is Rs. 7 to Rs. 30 (pre-war) and Rs. 10 to Rs. 45 (present).

(5) *Gill Nets.*—(*a*) Ayala Chala for mackerel, (*b*) Mathi Chala Valā for sardines. These are made of thin cotton thread 3 to 4 ply of No. 10. Unlike drift nets, these nets are operated only on sighting fish. Shoals are quickly encircled and the fish inside being frightened by the noise made against the canoes and against the surface of water by two iron balls each tied to a coir rope, get enmeshed in the net.

(6) *Drift Nets.*—These are of the following varieties and are all made of hemp:—

	Mesh.	Number and nature of ply used.
(*a*) Poocha Kandadi,	1¼ inch diagonally	3 thin ones.
(*b*) Kandadi,	1 to 1½ ,, ,,	3 thicker ,,
(*c*) Ayviral Kandadi, (five-finger meshed diagonally).	2½ ins. ,,	4 ,, ,,
(*d*) Odu Valā,	3 to 4 ins. diagonally	4 to 5 ,, ,,
(*e*) Narian Valā,	5 to 6 ,, ,,	6 to 7 ,, ,,
(*f*) Sravu Valā (shark net),	8 to 10 ins.	12 to 14 ,, ,,

The kind and size of fish caught in each varies as noted below:—

(*a*) Small sharks, valai and other smaller fish.

(*b*) Big valai, medium sized sharks and small seer.

(*c*) Big pomfret, medium seer, cat-fish and sharks.

(*d*) Big seer, palameen, big cat-fish, kora, rays, and big sharks.

(*e*) Special for narimīn (Lates calcarifer) and bigger sharks.

(*f*) Special for large sharks.

All the above-named drift and gill nets except Ayla Chala Valā are shot only in fleets of 10 to 15 pieces each varying in dimensions as given below :—

	Width of 1 piece	Length	Number of pieces.
1. Ayala Chala Valā,	5 fathoms	12 to 16 fathoms	1
2. Mathi ,, ,,	2½ ,,	5 to 6 ,,	10 to 12
3. Kandadi and Odu Valā,	2—2½ ,,	10 to 12 ,,	10 to 15
4. Shark net	2 ,,	8 ,,	10 to 12

All these except the last which requires a big canoe with five to six men, are operated from one small canoe manned by two to four men. Generally a group of canoes operate together.

(7) *Cheria Veppu.*—This is a long line with the line of even 1,000 fathoms long and with 1,000 hooks (1¼ inch long) each of which is suspended at every fathom by a string of about 1½ feet in length.

There are two big floats, one at each extremity, with a number of small ones between. Small pieces of fish, prawns, and cuttle fish are used as bait.

The cost of one long-line 1,000 fathoms long with hooks is Rs. 35 to Rs. 40 (present).

(8) *Sravu Veppu.*—This is also a long-line 100 to 200 fathoms long with 20 big hooks 5 to 6 inches long, but here the hooks are suspended not by a string but by a chain and the floats are much bigger; generally two tarred kerosene oil tins serve as floats, one at each extremity. Big pieces of beef are used as bait.

Sharks of big size are hooked in this. The cost of one Shark long-line is Rs. 25 to Rs. 50 (present).

The catches from our experiment may be taken as being more or less *typical of the Madras Coast.* The bigger fishes were individually weighed, while the smaller ones were measured by standard baskets the actual weight of which had been previously ascertained; so that the weight of the latter is fairly accurate. As the daily catches were auctioned wholesale by baskets in the case of small fishes and individually or by lots in the case of

bigger ones and were knocked down to the highest bidder each day, the value for the various kinds of fishes is proportioned according to that day's market rate which by the way depends on the following considerations :—

1. The time of the arrival of catch : good price if in early morning or late afternoon.

2. The condition of the catch.

3. General abundance or scarcity of fish.

4 The nature of the day of the sale—the bulk of the consumers being Hindus, the catches fetch a low price on all fasting days, e.g., all Saturdays, fullmoon days, krithigai days, etc.

Thus the value noted in the tables given below is the wholesale price.

How far each of the various nets and lines tried contributed towards this year's catch will be seen from the following list :—

	Weight of catch.	Value of catch.		
	LB.	RS.	A.	P.
1. Paithu Valā	52,093½	3,743	2	9
2. Vakku Valā	500	19	4	0
*3. Sulthan Valā and Kolli Valā ...	22,404½	1,562	4	0
4. Chala Valā	33,274½	1,306	13	9
5. Ozhukku Valā (drift-net) ...	1,480½	158	14	6
6. Veechu Valā (cast-net) ...	1,062	98	1	3
7. Cheria Veppu (long-line) ...	609	73	9	6
8. Sravu Veppu (long-line with big shark hooks)	130	5	8	0
9. Kai Chūnda (hand-line) ...	111	9	2	6
	111,665	6,976	12	3

From the above it will be seen that Paithu Valā, Chala Valā and Sulthan Valā yeilded the great bulk of our catches. Drift-net, cast-net and long-line rank next : the others are negligible. There are no West Coast nets to capture shrimps (Sennakuni) and large mullets which are occasionally got in large numbers by the local men in their minute meshed Eru Valai and Eda Valai (square net).

* Kolli Valā was tried first and then it was amalgamated with Sulthan Valā to form a big Sulthan Valā.

The total weight and value of the thirteen most important food-fishes of Madras caught by our canoes during 1919 are as follows :—

	LB.	RS.	A.	P.
1. Mackerel	36,088	1,879	13	3
2. Ceedai (Clupia kanagurta) ...	32,556	1,797	8	9
3. Kavalai (C. melanura)	10,337	625	2	3
4. Karapodi (Equula spp. Gazza spp.)	10,141	624	13	9
5. Netheli (Engraulis spp.)... ...	3,110	324	7	3
6. Prawns	2,941	286	10	9
7. Mullets	2,801½	264	4	3
8. Oola (Sphyræna spp.)	1,353¼	147	0	0
9. Cat-fishes	1,758	141	14	0
10. Manangu (Engraulis spp.) ...	1,252	100	6	0
11. Valai (C. dorab)	912	92	11	6
12. Sharks	680	75	12	6
13. Pachaikutti (Chatœssus spp.) ...	853	69	0	0

It is thus clear that mackerel and clupeids top the list in 1919 in Madras waters, while, according to the statistics on the fishing Industry of Tuticorin published in report No. 3 of Madras Fisheries Bulletin No. 11, it is Valai (C. dorab) that stands out most prominently among the food-fishes at Tuticorin; this has been more or less constant during the four years 1911 to 1914, under review there. As the data collected during the Inshore Fishing Experiment in 1917–18 are not so complete as in 1919, only a rough comparison between the two is possible.

Unlike the year 1919 mackerel were found only sparingly in 1917–18 when clupeids formed the most important food-fish at Madras.

The following table gives month by month the total weight and value of our catch in the year 1919 :—

	LB.	RS.	A.	P.
January	14,675½	877	5	3
February	29,681	1,087	0	9
March...	4,622	360	9	0
April	5,668¼	406	6	9
May	12,657½	979	9	3
June	13,875½	1,054	5	0
July	6,077	387	12	6
August	2,760	206	9	6

	LB.	RS.	A.	P.
September	3,776	294	9	3
October	9,401	616	0	3
November	4,511	351	7	6
December	3,960¼	355	1	3
	111,665	6,976	12	3

The average value per lb. is about an anna.

From the above it is clear that February gives us the maximum catch of the year and that January and February during the north-east monsoon and May and June during the south-west monsoon are the most prolific months for the Madras fishery.

October yielded a fairly good haul. August was the least productive month of the year.

The following table shows the total weight and value, for the year 1919, of all the *chief* kinds of fishes that sent up the receipts during these five important months :—

	LB.	RS.	A.	P.
January—				
1. Mackerel	8,073	380	9	6
2. Prawns	1,857	196	4	0
3. Clupea kanagurta	2,810	115	12	3
4. Mullets	336	57	3	6
5. Vala	524	46	9	6
February—				
1. Mackerel	19,444	701	3	9
2. C. kanagurta	8,299	229	4	0
3. Prawns	890	67	8	0
4. Cat-fishes	320	29	2	0
5. Manangu (Engraulis spp.) ...	325	27	12	0
May—				
1. Mackerel	2,861	285	5	0
2. C. kanagurta	4,794	263	8	6
3. Netheli	1,315	151	13	0
4. Karapodi	2,100	128	10	0
5. Sharks	242	33	9	0
June—				
1. C. kanagurta	8,345	590	8	0
2. Mackerel	1,426	158	5	0
3. Karapodi	1,901	118	14	0

	LB.	RS.	A.	P.
June—*cont.*				
4. Netheli	715	67	0	0
5. Mullets	490	47	2	0
October—				
1. C. melanura	7,310	442	4	3
2. Mackerel	1,042	83	12	0
3. Mullets	154	21	2	0
4. Vala	180	17	3	0
5. C. kanagurta	155	13	12	0

An examination of the above shows that mackerel, clupeids, prawns, karapodi and netheli account for such a marked increase in the quantity of the catch during these five months.

I was informed by the local fisher-folk and others in a position to know that the presence of such large shoals of mackerel as was witnessed during 1919 was unusual. It was considered by many as a godsend to save the poor fisher-folk and others from starvation due to famine conditions resulting from the late world war. This view of the abnormal nature of the shoals in 1919 receives confirmation from the data for the 1917–18 Inshore Fishing Experiments, when clupeids (C. melanura mostly and C. kanagurta) and prawns form the most important kinds of that year's catch; mackerel were got only in very small quantities; there has been this year a perceptible decrease in the quantity of prawns caught.

I infer from what the local fisher-folk have told me that mackerel shoals appear annually but last only for a few days and then disappear. I have also heard some say that once in every four or five years there used to be comparatively big hauls of mackerel but anything like their abundance and the longer stay in 1919 was never observed within the last twenty years or so. Whether there is actually any such cyclic appearance of big mackerel shoals in Madras waters as is commonly believed or if the time of their annual migration here is fairly constant can be positively stated only after a statistical study covering a number of years.

Mackerel Fishery Season, 1919.—With the exception of March, July and August mackerel were caught throughout the year as can be seen from the table below:—

	LB.	RS.	A.	P.
January	8,073	380	9	5
February	19,444	701	3	9
March	11*	......		

* Given as bait to long-line men.

	LB.	Rs.	A.	P.
April	254	27	12	0
May	2,861	285	5	0
June	1,426	158	5	0
July	13	1	9	0
August	...	......		
September	2,193	160	9	0
October	1,042	83	12	0
November	659	67	12	0
December	112	13	0	0
	36,088	1,879	13	3

It was in February they were found in plenty. On the whole it may be taken that the five months, viz., January, February, May, June and September, are the favourable seasons for the mackerel fishery, that is, 2 months during the north-east monsoon and 3 months during the south-west monsoon. From the data for the year 1917–18 given below—only two big canoes and a crew of 14 men were at work then and had no Chala valā (mackerel net) —it can be seen that only 1,189 lb. of mackerel were caught throughout the year and sold for Rs. 104-15-0.

	LB.	RS.	A.	P.
1918, May	135	14	0	0
1917, July	41	7	8	0
„ August	1,013	83	7	0
	1,189	104	15	0

But curiously it was in August 1917 that the maximum quantity was captured and they were not found during the other months of that year.

The time of their appearance and disappearance during the three years 1917—19 is noted in the following tables:—

1917		No data available till June.
	July ...	Appeared on 3rd July 1917 Disappeared on 7th July 1917
	August ...	Appeared on 17th August 1917 Disappeared on 31st August 1917 and thence forward never found till the close of December 1917.

1918 ...		Never sighted till 26th May and continued to be found till 31st May. After which no data are available, till their appearance (adult 8″—11″ long) on 20th December 1918 was noted: and they continued to be found till the end of December 1918.
1919 ...	January ...	Throughout found.
	February ...	Disappeared on 26th February 1919.
	April ...	Re-appeared only for one day (only a small quantity) on 13th April 1919, never seen from the next day till 21st April 1919 but these were young ones (4″—7″ long).
	May ...	Found throughout.
	June ...	Do.
	July ...	Disappeared on 5th July 1919.
	August ...	Not found throughout.
	September.	Re-appeared on 16th September 1919. (Young ones 7″—9″ long) and continued on in large numbers till the close.
	October ...	Throughout found.
	November ...	Do.
	December ...	Disappeared on 3rd December 1919 but very sparingly found occasionally till the end.

During this year the mackerel were invariably found in company with Clupea kanagurta till September and thence with Clupea melanura.

Spawning season.—The spawning season for mackerel appears to be October to December and the minimum size for maturity so far noted is 7·5″ in length.

The maximum length found here is 9·5″.

As during the year 1919 no young ones below 4″ in length were found in our catches, it is to be inferred that they go elsewhere, perhaps farther out in deeper parts of the sea, for spawning.

2. *Clupea kanagurta.*—This clupeid was found throughout the year except March and November. The maximum catch was in June; i.e., December to February in north-east monsoon and April

to July in south-west monsoon, appear to be the season for this clupeid.

November to December is the spawning period.

6″ is the minimum length for maturity and the biggest fish caught here measured 8″.

The younger specimens of this species have invariably a few dark spots which vary in individuals on the dorsal side as is the case with the young mackerel.

These being Plankton feeders as mackerel were generally found together in shoals.

3. *Clupea melanura.*—This species was found, in large numbers at any rate, only during the close of the year and were often hauled up along with Clupea kanagurta and mackerel. They were found in plenty only in October and November. Only a few measuring 5·6 to 5·9″ in length were found to have just developing gonads in October. The biggest specimen caught on 16th October 1919 measured 6·8″ and this was found to have no gonads. This species which occupies only a third place in the order of this year's catch occupied the foremost place during 1917–18 and Clupea kanagurta was then found only in a small quantity in May 1918.

4. *Prawns.*—These were found in large numbers only in January and February of which the former gives us the bigger haul. The total weight and value for this year were 2,941 lb. worth Rupees 286–10–9 whereas during the year 1917–18 they were the second important item of catches. With a crew of only 14 men they had 2,534 lb. worth Rs. 230 as detailed below :—

	LB.	RS.	A.	P.
1918, February	320	21	8	0
,, May	468	67	2	0
1917, July	15	2	12	0
,, December	1,731	138	10	0
Total ...	2,534	230	0	0

That is, there has been this year a considerable decrease in the prawn catch.

5. *Netheli.*—May and June are the best months for Anchovy fishery and the former is by far the most important. The last five months, August to December, yield a fairly moderate catch.

October to November is the spawning period: 2·1″ is the minimum length for maturity in one species. The biggest specimen measured 4·8″ in length.

6. *Hilsa.*—This was caught only twice during the year as noted below:—

	LB.	RS.	A.	P.
1919, April	4	0	4	0
,, August	365	31	8	0
Total ...	369	31	12	0

The following table furnishes the data of their appearance and the quantity caught:—

1919, August 7th ...	First caught off Mylapore by the local fishermen in their Vala Valai. They measured 12″ to 15″ in length, one of which 13·5″ long had just developing ova.
,, ,, 9th	238 were caught in our Chala Vala and drift nets.
,, ,, 10th	145 were caught in our Chala Vala.
,, ,, 11th	Only a few were caught.

They were never seen again till October 4th, when a few were caught by local men.

August to September seems to be the spawning season for Hilsa. All the five specimens examined on 9th August 1919 were females with about half-matured ova and these specimens measured 11·5″ to 14″ long. Evidently these being anadromous, were from the shoals that were on the look out for any river mouths through which to ascend higher up for spawning.

General points of interest.—Our fishing operations were greatly hampered for about a month and a half by the appearance in the inshore area of swarms of jelly fishes, 2″ to 3″ in diameter, from 19th March to 30th April 1919. These appeared even the previous year by 2nd April 1918 and disappeared by 11th May 1918. Hence they seem to be periodical visitants to Madras waters at about the same time every year; during 1919 their appearance and disappearance were a fortnight earlier. The prevalence of strong south-west and west winds from 17th to 20th March 1919 coincides with this phenomenon.

On 19th December 1918 and 22nd January 1919 strong north or north-east winds washed ashore on the Rayapuram beach (Madras) multitudes of Siphonophores (Physalia, Velella and Porpita) and a few Janthina (Pelagic gastropod).

ANNEXURE I.

The relative monthly productiveness of the chief methods of fishing tried during the inshore fishing experiments in 1919.

No. (1)	Method of fishing. (2)	January. (3) LB.	January. RS. A. P.	February. (4) LB.	February. RS. A. P.	March. (5) LB.	March. RS. A. P.	April. (6) LB.	April. RS. A. P.	May. (7) LB.	May. RS. A. P.	June. (8) LB.	June. RS. A. P.
1	"Paithu Vala"	4,094	357 9 9	4,984	250 6 0	3,764	281 0 6	4,969¼	346 9 9	9,331½	715 2 9	8,749	684 9 0
2	"Sulthan Vala"	...	...	..	..	...	...	...	...	2,510	172 10 0	4,523½	334 15 0
2-A	"Kolli Vala"	..	...	2,110	62 15 6	...	...	..	...	...	...	.	..
3	"Vakku Vala"	..	...	..	..	..	...	...		...	..	500	19 4 0
4	"Chāla Vala"	10,292	487 12 6	22,254	742 11 3	...	...	30	1 14 0	50	5 14 0	...	...
5	"Ozhukku Vala" (Drift Net).	113½	12 13 6	325	30 5 0	305	26 7 0	153	13 15 0	490	64 14 0	...	...
6	"Veechu Vala" (Cast Net) ...	150	16 6 6	8	0 11 0	313	34 10 6	258	20 9 0	252	18 8 6	...	...
7	Long-line	26	2 11 0	...		110	12 15 0	167	16 0 0	24	2 8 0	93	14 9 0
8	Hand-line	...	...	...	...	...	...	91	7 7 0	...	...	10	1 0 0
9	Long-line with big hooks ...	...	...	...	..	130	5 8 0	..	...	..	...	..	...
	Total ...	14,675¼	877 5 3	29,681	1,087 0 9	4,622	360 9 0	5,668¼	406 6 9	12,657¼	979 9 3	13,875½	1,054 5 0

No.	Method of fishing.	July. (9) LB.	July. RS. A. P.	August. (10) LB.	August. RS. A. P.	September. (11) LB.	September. RS. A. P.	October. (12) LB.	October. RS. A. P.	November. (13) LB.	November. RS. A. P.	December. (14) LB.	December. RS. A. P.	Total. (15) LB.	Total. RS. A. P.
1	"Paithu Vala"	4,183	260 14 6	367	26 3 0	...	...	4,354	229 8 6	4,320	334 7 6	2,977¾	256 11 6	52,093½	3,743 2 9
2	"Sulthan Vala"	1,837	119 1 0	1,904	129 2 6	3,382	249 2 3	5,047	386 7 9	191	17 0 0	900	90 14 0	20,294½	1.499 4 6
2-A	"Kolli Vala"	...	...	...	...	..	...	..	...	...	...	...	...	2.110	62 15 6
3	"Vakku Vala"	...	...	...	...	...	.	...	...	...	...	...	...	500	19 4 0
4	"Chāla Vala"	...	...	378½	39 3 6	270	29 6 6	...	..	...	...	...	...	33,274½	1,306 13 9
5	"Ozhukku Vala" (Drift Net).	35	5 8 0	57½	4 12 0	...	...	...	...	...	...	1½	0 4 0	1,480½	158 14 6
6	"Veechu Vala" (Cast Net) ...	...	...	...	.	...	..	...	...	...	...	81	7 3 9	1,062	98 1 3
7	Long-line	22	2 5 0	47	6 13 0	120	15 12 6	...	...	...	...	...	...	609	73 9 6
8	Hand-line	...	...	6	0 7 6	4	0 4 0	...	...	...	...	...	...	111	9 2 6
9	Long-line with big hooks ...	...	...	...	...	...	...	...	...	...	...	...	...	130	5 8 0
	Total ...	6,077	387 12 6	2,760	206 9 6	3,776	294 9 3	9,401	616 0 3	4,511	351 7 6	3,960¼	355 1 3	111,665	6,976 12 3

ANNEX

Monthly statistics of catches from Rayapuram

Number.	Kind.	January.		February.		March.		April.		May.	
(1)	(2)	(3)		(4)		(5)		(6)		(7)	
		LB.	RS.	LB.	RS.	LB.	RS.	LB.	RS.	LB.	RS.
1	Mackerel	8,073	381	19,444	701	11	...	254	28	2,861	285
2	Clupea kanagurta ...	2,810	116	8,299	229	...	...	3,117	197	4,794	264
3	Clupea melanura ...	...	...	...	...	...	...	94	8	...	...
4	Karapodi	200	10	110	7	1,200	80	500	26	2,100	129
5	Prawns	1,857	196	890	67	6	1	9½	2	29	4
6	Sharks	64	6	35	3	159	9	70	8	242	34
7	Shrimps	20	1	...	...	111	4	...	..	...	...
8	Rays	65	3	5	½	10	1	...	...	17	2
9	Cat-fishes	94	8	320	29	104	12	351	29	189	20
10	Netheli (Engraulis spp.).	...	...	...	...	4	...	5	1	1,315	152
11	Trichiurus savala ...	87	7	...	...	...	...		...	...	...
12	Mullets	336	57	105	12	1,240	96	310	18	148	10
13	Caranx spp. ...	2½	½	...	...	2	⅛	15	1	...	...
14	Vala (Chirocentrus dorab).	524	47	15	1	11	1	...	...	63	10
15	Chanos salmonius.	23½	4	...	...	48	9	...	..	...	...
16	Elops saurus ...	...	...	...	...	1½	¼	7	1	...	...
17	Sphyræna sp. ..	50	3	...	...	...	...	541	57	...	...
18	Lacterius sp. ...	.	..	...	...	...	...	...	...	15	2
19	Chatoessus spp. ...	251	18	..	...	460	38	57	5	15	2
20	Serranus spp. ...	3½	¼	...	...	43	5	...		10	1
21	Sciæna spp. ...	22	5	65	4	28	3	15	2	80	9
22	Seer	6	2	...	...	...		14	2	17	4
23	Pomfret	...	..	...	...	20	8	...	..	...	..
24	Polynemus spp. ...	90	7	...	...	27	5	.	...	...	...
25	Pellona spp. ...	10	1	...	...	...	.	...	...	...	...
26	Chorinemus sp. ...	..	...	...	..	...	...	...	...	...	...
27	Crabs	6	½	...	...	...	...	...	...	...	...
28	Saurida tumbil ...	5	½	...	...	...	...	...	...	...	...
29	Chrysophrys sp. ...	2	¼	...	...	...	...	...	...	...	...
30	Manangu (Engraulis sp.).	...	..	325	28	570	46	..	..	50	4
31	Megalops sp. ...	...	...	...	...	20	3	...	...	...	...
32	Belone sp. ...	...	...	...	...	39	5	...	...	...	...
33	Thynnus sp. ...	...	...	...	...	150	7	..	...	...	..
34	Eels (Muraenesox spp.)	...	...	...	...	26	1	15	3	51	6
35	Mothakendai ...	...	...	...	...	...	...	125	10	200	14
36	Cuttle-fish	...	...	...	...	...	...	12¾	1	1½	¼
37	Hilsa	...		...	...	...	...	4	¼	...	...
38	Lates calcarifer ..	...	.	...	...	...		...	.	15	2
39	Platycephalus insidiatrix.	...	...	...	...	1½	¼	...	.	..	...
40	Miscellaneous ...	74	4	68	4	330	23	152	8	445	26
	Total ...	14,675½	878	29.681	1,086	4,622	357	5,668¼	407	12,657½	980

URE II.

Inshore fishing experiments for the year 1919.*

June.		July.		August.		September.		October.		November.		December.		Total.	
(8)		(9)		(10)		(11)		(12)		(13)		(14)		(15)	
LB.	RS.	LB.	RS.	LB.	RS.	LB.	RS.	LB.	RS.	LB.	RS.	LB.	RS.	LB.	RS.
1,426	158	13	2	...	...	2,193	161	1,042	84	659	68	112	13	36,088	1,881
8,345	590	2,691	180	680	49	260	21	155	14	...	...	1,405	138	32,556	1,7[illegible]8
...	..	658	35	...	...	195	15	7,310	442	2,080	125	...	..	10,337	625
1,901	119	1,500	110	900	45	200	9	80	2	300	15	1,150	73	10,141	625
...	...	23	3	.	..	90½	10	...	...	...	...	36	4	2,941	287
7	1	20	2	3	¼	80	11	...	...	...	...	...	...	680	74
...	...	1	1/16	...	...	..	...		...	...	...	5	¼	137	5
38	4	...	.	8	½	...	...	5	½	...	..	..	...	148	12
532	24	42	4	33	4	38	4		..	40	6	15	2	1,758	142
715	67	16	3	84	16	240	24	216	17	270	21	245	23	3,110	324
...	.	44	4	40	3	...	...	33	3	171	14	...	...	375	31
490	47	...	...	6	1	...	...	154	21	4	½	8½	2	2,801½	264
3	½	1	⅛	20	3	½	1/16	10	½	158½	17	246½	29	459	52
...	..	1	⅛	42	9	20	2	180	17	40	3	16	2	912	92
18	4	...		...	...	...	..	...	...	10	1	4	1	103½	19
...	...	11	1	6	1	6	1	4	½	8	1	2	¼	45½	6
...	...	...	...	...	...	3	½	41	3	543	64	175¼	20	1,353¼	147
...	...	...	...	...	...	6	1	20	2	18	2	20	2	79	9
...	...	...	...	10	1	...	...	60	4	...	...	...	...	853	68
36	4	...	.	8	1	4	¼	...	...	...	...	...	...	104½	12
21	2	...	...	...	...	1	⅛	...	...	2½	¼	188	18	422½	43
...	...	15	3	3	1	7	3	1	¼	½	¼	3½	1	67	16
...	..	5	1	...	...	...	...	...	...	...	...	...	...	25	9
2	½	...	...	...	...		...	...	...	...	...	...	...	119	13
...	...	...	..	365	27	210	17	...	...	...	...	...	...	585	45
50	7	...	...	...	...	...	...	...	...	50½	8	...	...	100½	15
...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	½
...	...	...	...	.	...	...	...	..	...	...	...	...	...	5	½
...	...	...	...	...	...	...	..	...	...	...	...	1½	¼	3½	½
...	...	...	...	12	1	60	4	50	3	...	...	185	14	1,252	100
5	1	...	...	...	...	...	...	...	...	1	⅛	90	9	116	13
...	...	...	...	...	...	...	...	...	...	...	...	...	...	39	5
...	...	...	...	...	...	...	...	...	...	...	...	...	...	150	7
22	2	18	2	9	1	12	2	...	..	...	...	12	1	165	18
...	...	...	...	...	...	50	4	...	...	...	...	...	...	375	28
½	⅛	10	1	14	2	...	...	..	...	...	..	...	...	38¾	4
...	..	...	...	365	31	...	...	...	...	...	...	...	...	369	31
36	8	..	...	...	...	...	...	...	.	...	...	...	...	51	10
...	...	...	...	...	...	...	...	...	...	...	...	...	..	1½	¼
228	14	1,008	35	152	10	100	4	40	2	155	5	40	2	2,792	137
13,875½	1,053	6,077	386	2,760	207	3,776	293	9,401	616	4,511	351	3,960¼	355	111,665	6,969

* Value brought to the nearest rupee.

ON THE METHODS OF CAPTURE AND SUPPLY OF FISH IN THE RIVERS OF THE NILGIRI DISTRICT

BY

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THE BHAVANI RIVER.

From the source to the falls where it is joined by the Billithada Halla, the Bhavāni passes over a rocky and precipitous bed through thick jungle. This upper portion which teems with animalcules and valuable fish food contains no fish of any consequence. As the river approaches Bane village, the bed consists of huge boulders and deep pools. Here again a large quantity of live fish food is to be found consisting of mollusca, larvæ of the "dragon" and numerous other flies and animalcules. The pools are occupied by a variety of "stone loach"; the mahseer and other big fish not being able to ascend so far.

Spawning beds.—The river continues to flow over a rough and rocky bed for some miles. The first and highest spawning beds are found near the village of Kardigamund.

Poaching.—Just below this on the broad shallow reaches, I came across poaching with fixed engines in the shape of basket traps.

Construction of miniature dams.—These reaches which lend themselves to this kind of poaching were lined across with a series of V-shaped miniature dams, constructed by placing together stones packed with leaves, branches, etc. The flow of the river is thus diverted in each case to the apex of the V at which point is placed a basket trap.

Construction of fry trap.—This basket trap is constructed of finely laced bamboo strips, so closely woven that the smallest fry

once inside could not escape. The aperture or entrance is shaped with inverted bamboo strips, so arranged that it is easy for fish to pass in and next to impossible for them to get out again. At the other end of the trap, the bamboo strips are twisted together and tied. The fry following their natural instinct to pass down-stream, move with the converging (artificial) main channel and thus into the trap at the apex, there being no means of escape.

That shoals of fry are captured this way is evident. The first trap I raised contained some hundreds of these helpless mites.

Poacher's views on fry trapping.—On questioning the man who was setting these traps, he said that "he thought it was quite a legitimate means of capturing small fish," but complained that the catches were getting scarcer every year. To make up for this deficiency, he had to make his traps more effective thus preventing a smaller percentage escaping.

Collecting the spoil.—Having lifted the trap, the poachers untie the string and deposit the fish into another basket and replace the trap as quickly as possible. During the short interval when the trap is out of position, a few fry escape, but I noticed lower down the river that they carry an additional trap which they place in position immediately after removing the first one. Formerly (I was informed) they examined the baskets every few hours, but now this is not necessary as the supply has diminished so much. Every evening just before dark, they examine and replace the traps, which remain in position all night.

Time of operations.—These traps are constructed on the first appearance of fry or immediately after the flooded river subsides. Being practically on some of the spawning beds themselves, they capture mere alevins. The operations were in full swing when I passed down in November.

District in which this destruction is practised.—The district in which this wholesale destruction of immature fish is practised constitutes the main spawning grounds of the Bhavāni. Beginning beside the village of Kardigamund these fixed engines are to be found near each village down to Sindaṅarai just above Attapadi.

Damage to fish in the river and number of people who benefit.—The damage done to the future supply of fish in the river in this area

must be enormous, and the number of people who benefit comparatively small. The villages contain a small population and are few and far between. After running the gauntlet of all these fixed engines, the few fry that escape have their natural enemies to contend with.

Mature fish trapping.—The trapping of big fish with fixed engines starts just above Attapadi. The remains of an immense trap, which has been in use last season and partly destroyed, can be seen some 400 yards above the Attapadi ford. It is constructed of stakes driven into the river bed among which strong bamboo strips are interlaced and the whole forms a closely barred gate across the main channel. In the centre of the gate, a square aperture is left for the insertion of a large basket trap of similar construction to the fry engine, only larger and stronger.

Places where these traps are constructed.—The places that are favourable for the construction of this fixed engine are those in which islands split the main stream into a series of channels. The channel where the largest flow of water passes is selected for the gate, which is supported by Y-shaped stakes driven into the bed at an angle to withstand the water pressure. The other channels are all obstructed by long bamboo-laced hurdles, which entirely prevent the big fish passing, thus driving them to the main stream and gate.

Area over which gates are found.—The area over which these traps are to be found on the Bhavāni is from above Attapadi to within a quarter of a mile of Sundapatti.

Time when fish run to spawning beds and return.—The big fish run up to the spawning grounds in the upper reaches of the Bhavāni during the south-west monsoon when the river is in spate, returning as soon as the higher waters begin decreasing during August, September and October according to the season.

Time when gates are constructed.—As soon as the heavy rains have stopped the people start constructing these fixed engines.

Other methods of poaching.—The other methods of poaching adopted on the Bhavāni in the district I visited consist of "fishing with night lines, small mesh netting, poisoning, beating the pools when water is low (during dry season), dynamiting the pools, etc." Those that came under my notice during my visit I enumerate below.

Night lines.—Fixed stakes to which night lines are attached can be seen in large numbers protruding from the banks of the river, islands, etc., from Munjikundy to below Sundapatti.

Dynamite.—At Pallaloor and Mel Parali, there were quantities of big fish scales, in heaps on the banks of the river near to very deep pools and no trace of any traps. This points to some explosive having been used and most probably dynamite. In cases of poison, the fish are collected (as they sicken) down the stream. With an explosive, they are gathered while stunned at the foot of pool operated on. In this latter case it is natural to find the scales as described above.

Wholesale waste of immature fish compared with value as food-supply.—The fry that are captured on the highest reaches are so exceedingly small, that it must take a very large quantity to be of any use for a single meal for a man. These people thus take a heavy toll of the future stock of the river in this way, and in return get an infinitesimally small amount of food compared with the number of fish killed.

The local inhabitant's one idea is to get as many fry as he can and by any means, regardless of the future supply.

He knows their natural instinct to move down-stream and does his utmost to make the traps effective to prevent any escape.

Value of the big fish as food-supply when captured just after spawning.—The amount of wholesale food obtained from "spent" fish is small and entirely confined to the male fish. Although the male goes slightly out of condition, the loss of his milt does not affect him so seriously as the depositing of the eggs by the female.

The flesh of a female at this period is unwholesome and not fit for human consumption.

METHODS SUGGESTED TO PREVENT WHOLESALE SLAUGHTER OF FISH IN THE BHAVĀNI.

(1) I suggest the first step to be taken to bring this river back to its full fish-bearing capacity is to enforce the Act *re* "fixed engines."

(2) To do this, it will be advisable to appoint watchers to reside in and watch the area where fry and mature fish traps are constructed.

(3) To make it an offence to capture fry *by any means* on or just below spawning beds.

(4) To have a close season for mature fish during and immediately after spawning time.

(5) During the hot months when the fish are mostly confined to the *pools*, beating and poisoning goes on (I am informed) to a large extent. Means must be adopted to stop this serious offence. Where the river is diverted into side channels for purposes of irrigation, the entrance should be trapped with properly constructed iron grating.

Dams.—Where dams have been built that prevent fish passing up-stream, fish ladders should be constructed so as to allow an easy passage both ways.

It will be advisable in the future when anicuts are being constructed to provide fish ladders in each case.

The actual cost will be small compared with the future value of the river as a source of food-supply. In cases in which these are not provided, the fish collect in large numbers at the foot of the anicut and fall an easy prey to the poacher. They are also cut off from their spawning beds.

Duties of watchers.—Each watcher should patrol the river in the district to which he is appointed, should remove all fixed fry traps and destroy the artificial weirs used for capturing fry ;

Should be instructed as to the exact localities where these small weirs are built ;

Should destroy all fixed engines used for the capture of mature fish, taking care to remove the obstructions in side runners, described in the report as " hurdles " ;

Should prevent the construction of same ;

Should remove all fixed stakes used for night lines ;

Should keep a sharp look out for fresh fish scales on the banks and report the exact position, if large quantities are found ;

Should send into headquarters all basket traps seized.

Remarks.—To see that the watchers carry out these instructions, it will be necessary to inspect the river from time to time. Should any fixed engines be found, the watcher in whose beat they occur ought to be severely dealt with. As the construction of fixed engines for the capture of mature fish (judging by the nature of the trap) will take considerable time, they will be easy to detect. If each trap were destroyed during construction and careful watch kept at the places during August, September, October and early

November, the majority of the mature fish will safely pass this danger zone.

If the above suggestions are adopted, I have no hesitation in saying the river will improve as a source of food-supply by leaps and bounds each year.

The natural feeding (small live food, animalcules, etc.) I found in large quantities all down the river, and it has been naturally increasing as the fish decreased, so that the rate of growth of fish in this river should be rapid.

THE SIRUVANI RIVER.

27TH MAY TO 2ND JUNE 1907.

An ideal stream with large shade trees on both banks, long gravel reaches and deep pools the Siruvani undoubtedly is the best tributary of the Upper Bhavāni and as a breeding ground for fish is most valuable.

During my visit in May and early June, I viewed the river at its lowest as there had been no rain for many months.

The Gopaneri, a large tributary of the Siruvani, is entirely dried out, but the latter, on the other hand, has a splendid supply of water notwithstanding that all its lower tributaries are in the same dried up condition.

The flow of water (at this season) where it joins the Bhavāni is rather deceptive as the quantity of water is less there than that higher up the river. It is clear that the river loses by evaporation during its winding course and gathers no additional supplies from the dried up feeders. Judging by the flood marks the Siruvani rises to a great height during the wet season and has no natural obstruction to prevent fish passing up to the spawning beds.

In the more inaccessible deep pools of this river, Carnatic carp can be seen during this dry season in shoals feeding mostly on berries and leaves,—the leaf of the wild mango tree being a great favourite and eaten readily as it falls on the water. I caught several of these fish on the grasshopper and found the contents of their stomachs consisted entirely of vegetable matter. On the banks of nearly all the deep pools in the vicinity of villages, numerous carp scales were to be found, yet in the pools themselves, although very clear, no fish of any size could be seen. Poison is

the means adopted to capture these fish as is clear from the fact that scales are spread over the banks for some distance.

Fry traps.—I found two fry traps of similar construction to those described in my report on the Bhavāni, hidden in the undergrowth of one of the islands.

The mahseer ascend this river while it is in spate and some evidently travel a long way before depositing their spawn, as the fixed engines to catch them are found high up.

When the heavy waters are subsiding, which, I gather from the local inhabitants, is towards the end of August or early September according to the monsoon, they proceed to build the most formidable fixed engines from bank to bank. In one mile of river, I counted no less than four of these obstructions which had been working last season and were still stout and strong, but not in use, as the actual trap had been removed. All the mahseer that had escaped the traps had left the small river long ago for safer and deeper waters. The heavy floods which are due shortly will carry all these hurdles away, so they have to be rebuilt each year.

Fixed engines.—In construction these are similar to those used on the Bhavāni, if, anything, they are more stoutly built with heavy posts well driven into the river-bed and interlaced with bamboo and branches and supported by strong " Y " shaped stakes.

Being a small river the poachers have no need to take advantage of the islands as they do in the Bhavāni. They build straight across from bank to bank.

In two places where big trees had fallen across the river-bed, advantage had been taken of their support and traps built along them.

Up to the present I have not come across on any river so many fixed engines as I found up this splendid tributary of the Bhavāni.

The engines on the Moyar are primitive compared with those on the Siruvani and the Bhavāni, the inhabitants having given more attention to poisoning than trapping. This gives a rough idea of what the fixed engines were originally like.

Food-supply.—There is a large amount of fish food in the Siruvani, and as the country is well wooded, numbers of insects and much edible vegetable matter are constantly falling in the water.

Spawning ground.—The value of the river lies in its splendid spawning grounds which should be properly protected.

Suggestions, etc.—Owing to the difficulty of getting food and the excessive heat, I was unable to get up as far as the highest reaches. I will, however, visit and report on these at the first opportunity. That the people poach the fry is evident from the fact of finding the two fry traps, and as these were hidden no doubt word had been sent up the river before me. Should action be taken and the reconstruction of the fixed engines prevented, it would only affect the inhabitants for a few months in the year and at the time when their crops are in full bearing. The fry poachers of course would have to be dealt with after the big fish had left, but the stopping of this disgraceful destruction would not affect the communities but only the actual poachers and their families.

When on the Siruvani, I took the opportunity to go across the country close to Attapadi and come down the Bhavāni to see if there was any other kind of poaching going on at this time.

The river is very low and with the exception of disturbing a number of game poachers close to the river, I saw nothing new to report.

I continued down to Sundapatti and then on to Niralai.

In the big pools all the way down were large Carnatic carp. I examined some of their stomachs and found them full of vegetable matter.

Continuing on down by coracle towards Mēttupālaiyam I came across some men who had been poisoning or dynamiting the river. They were hiding in the long grass on an island and round about fish could be seen lying belly upwards on the surface of the water. I examined them, but they had no fish on them; they had also evidently thrown the poison berries away. As I could not actually prove from anything in their possession that *they* had done the poisoning, etc., I had to leave them; but it was a certainty they had.

Nearer Mēttupālaiyam poaching with the small casting net goes on from coracles, but as there are not many who own these coracles, they cannot do much damage.

THE MOYAR RIVER.

In reporting on this river, it is necessary, for reference, to divide it into three sections, each section being cut off from the other by immense falls impossible for any fish to ascend.

The sections I name as follows :—

(i) Pykara or Upper Moyar—Comprising the river from the source to the big " Pykara Falls."

(ii) Middle section of Moyar—From below these falls (where the river takes the name of Moyar) to beyond Teppakadu where it has a sheer fall into the Mysore Ditch.

(iii) Lower Moyar—From the beginning of the Mysore Ditch to where the river joins the Bhavāni.

Section I.—Pykara or Upper Moyar.

Temperature.

High reaches just below Mukurty Peak,	56°	Fahr.	11-15 a.m.	sun.
,, ,,	57°	,,	12-30 a.m.	,,
Below junction of small tributaries ...	58°	,,	11-0 a.m.	,,
Junction of Krurmund	60°	,,	10-45 a.m.	misty.
Island pool	63°	,,	2-15 p.m.	,,

The river rises close to Mukurty Peak and is joined towards the foot by another large tributary. Both the streams flow over a rocky bed with pools, occasional gravel deposits, and shade in places.

Below this several small tributaries join, and the main stream passing over rocky, sandy and gravel beds enters flat country where at this time (March) of year it consists of very shallow stretches and sluggish deep pools. A useful tributary enters called Mudimund stream with a temperature at 8-30 a.m. of 54 degrees Fahr. Below this the river passes over a small bed rock fall where it is joined by the Krurmund. From here downwards there are long sandy pools with gravel and rocky runs between. Below Pykara bungalow, there are considerable falls in the bed rock bottom, but not sufficient to prevent fish ascending in flood times. There are deep sandy pools and similar runs to those described above until it reaches the big Pykara Falls.

Carp.—Carp were introduced into this section from a river below Nadgani in Malabar some years ago and have thrived and bred to a large extent.

These Malabar carp seem to have distributed themselves over the greater part of this section. The highest point I observed then was in the sluggish pools of the flat country stretch above the entrance of the Krurmund river.

Above this I could find no trace of any fish except the indigenous minnow. The very shallow water intervening would no doubt drive them to the deep pools below for protection.

Habits.--The habits of this fish are to move about in shoals, to come close into the edge and often to feed in practically shallow water. They frequent the side-ditches or runners with steep grass banks during the heat of the day, these being especially favourite places when buffaloes are grazing near the banks. The buffalo disturbs small frogs which invariably jump into the ditch and are immediately eaten by the shoal which are waiting to seize them. The fish also enter very rapid water in search of food.

Contents of stomach.—On examining the contents of the stomach of several of these fish I found the following food: several small frogs, remains of small fish, dragon-fly larvæ, caddis, grubs and various animalcules.

Edibility.—The flesh is somewhat tasteless, but is highly prized by the people. Like most of the carp family it has large quantity of small bones.

The fish as an object of sport.—He is much superior to the Carnatic carp. He makes quite a sporting run, takes a spoon or live bait readily and can be caught in the rapid runs as well as still pools.

Live fish food.—In this section can be found indigenous minnow, mollusca, several variety of caddis, crab, dragon-fly larvæ, frogs and larvæ of numerous small flies.

Poaching.—The only poaching seems to be confined to occasional raids and to the use of dynamite. I have been informed by Mr. Hodgson that some poachers were caught in the act a few years ago with a large quantity of fish in their possession and were convicted and fined. In spite of these raids which are few and far between and of the legitimate fishing with rod and line, the Malabar carp have increased enormously. This section thus forms a guide of the possibilities of restocking rivers with coarse fish together with protection. All coarse fish are most prolific egg givers and if not interfered with in their spawning operations multiply enormously.

SECTION II.—MIDDLE MOYAR.

Carnatic carp.—This section stretching from the bottom of the Pykara Falls (where it takes the name of Moyar) down to the

sheer drop into the Mysore Ditch below Teppakadu is occupied principally by Carnatic carp. They grow to a fair size and are distributed all over the section.

Habits.—They frequent deep pools and can be seen moving up and down the edges in search of food, selecting places where trees overhang or where coarse grass grows on the banks. When the wild fig tree (which is common to this section) is in fruit, they can be found in shoals underneath it eagerly catching and eating the fruit as the wind or monkeys shake it from the trees. During this season he is a greedy feeder and goes on eating while greatly distended with undigested fruit. During my visit a large branch of one of these trees had been pulled down (evidently by an elephant) and the bushy end was dangling in the river. I noticed a great disturbance of the water in the vicinity and partially dismembered branch being continually pulled. On investigation I found a school of carp eagerly biting off the fruit and at each pull other ripe berries dropped off, the disturbance of the water being caused by the keen competition of the numerous fish to seize them as they fell.

Food.—Baiting with a berry I secured and examined the contents of one of the school. The outward appearance would suggest a fish full of spawn, but on opening I found a sticky mass of undigested fruit distending the stomach to its utmost capacity. They seem to gorge themselves entirely with these berries, when able to procure them in any quantities and neglect for the time being other numerous sources of fish food. In pools where there are none of these trees on the banks, the Carnatic carp move up and down close to the edge and secure numerous grasshoppers which the coarse overhanging grass harbours in thousands.

Contents of stomach.—I examined the contents of several fish and found a quantity of grasshoppers, shrimp and a lot of small larvæ. They also contained a certain amount of vegetable matter, but as it was half-digested it was difficult to identify.

The fish as an object of sport.—They give one good run and, if caught in rapid water with fine tackle, are quite game at first, but soon give in.

Poaching—Fry traps.—In the upper reaches I found traces of small traps placed across side runners or ditches, which were then dry. They had evidently been in use during the last floods and allowed to remain.

Construction.—Constructed of wood in the shape of a large "rake head" with long teeth close together, they are fastened securely across the ditch or runner at a slight angle with teeth in the gravel.

The object is to capture the small fry which frequent these side places for protection during flood times. In some of them the teeth could be raised from the gravel by turning the top cross piece to allow anything to enter, the others evidently were constructed as the floods were finally subsiding and the fry would be already in. Judging by their primitive nature and poor construction they are not effective, but will do a certain amount of damage.

Poachers.—The nearest hamlet to this place is called Torappalli, occupied by a few fisherpeople called Paniyans. These are no doubt the makers of the traps, and from information, I received, they are said to possess better fry and other traps, but I could find no trace of them. They are also credited with having fine mesh nets which they use when the waters are low. I never found these however and expect they would have hidden them away when they heard I was visiting the river.

Fixed engines.—I found no trace of fixed engines in this section of the Moyar. So they must rely on other methods *not so effective* to capture the fish.

Poison.—I am informed that poison is used during the dry weather above and below Teppakadu, but to what extent I had no means of judging.

Fish food.—This section abounds with fish food of great variety; the temperature of the water being warmer than that in section (I) everything of this nature is found of a larger size. Large mollusca, shrimp, dragon-fly larvæ, crabs and an abundance of numerous animalcules I have collected and preserved specimens in formalin. It is the custom for the people on this section to fish for crabs which they eat with their curry. To catch them they split open one end of a thin bamboo stick and insert a small fish with the head protruding. They then wade up the river poking this under the edge. The crab seizes hold and in this way they gather large quantities.

Remarks.—Not knowing the early history of this section of the Moyar I am unable to state whether it has been badly poached and depleted of fish, but judging by one of the sure signs, i.e., the

prevalence of such quantities of live fish food, it seems clear that the river is not nearly carrying its full fish-bearing capacity. Owing to the easy approach and nearness of the main Gudalur-Masinigudi road to the middle portion of this section and the easy access to the upper and lower reaches, I consider it would be easy and cheap to protect.

Suggestions—Re-stocking.—I suggest that this section should be stocked with Malabar carp or other suitable fish such as mahseer.

If granted permission I could transfer a quantity of the former under my own supervision from the Nadgani or other Malabar rivers.

Carriers and nets.—Suitable carriers and nets I have already in my possession.

SECTION III.—LOWER MOYAR.

Starting from below the high falls into the Mysore Ditch down to where the river joins the Bhavāṇi this section has no *natural* obstruction and fish can pass along the entire distance.

Description of the high reaches.—Immediately below these falls the river has a solid rock bed with narrow precipitous unapproachable sides and few men ever venture up so far.

It is here free from traps and poaching. It flows over a rocky and rough bed which, after some distance, is replaced by gravel reaches broken by small islands. As the ditch opens out and allows room for camps on the banks, the signs of poaching are evident and various.

Artificial dam.—The first I came across was an artificial dam constructed from an island to one side of the river, the flow being diverted to the opposite side and trapped with a wooden hurdle similar to that used in the Bhavāni and described in my report.

Construction of dam.—The dam was constructed of stones, mud, leaves and branches firmly set together and built in the shape of a crescent, thus forming this portion of the river into a still pool with no through flow, the object being to cause the fish to collect and make the poison which they use to capture them more effective.

Evidence of poison.—On examining the banks beside the dam I found numerous small dead fish including small eels evidently cast aside as not being large enough to take. On the island were masses of fish scales and similar patches at the side of the artificial pool.

Fixed engines.—The round hard shell of the poison berry used lay about in quantities. Having destroyed this dam and one or two smaller ones lower down I came across the first series of fixed engines.

Construction of cradle trap.—It is constructed in the shape of a large cradle with the end opposite to the hood knocked out. This end with raised sides is firmly set level with the bed of the river and the hood end is supported on stout stakes some two or three feet above the water level. These are generally built where islands occur, and as a rule one side of the cradle is made fast to the island while the other has a hurdle running to the opposite bank to prevent fish passing. The people sometimes build two or three cradles in a line but generally two, one on each side of an island.

Where the river has a narrow pass between two islands the cradle would occupy the entire space. Any open water would be guarded with hurdles.

Effectiveness of cradle trap.—These cradle traps if kept in good order are effective while the river has a good supply of water, but when low a lot of them would become practically useless. It is clearly seen they are intended to catch the fish descending, after spawning operations and I should say large quantities are destroyed this way.

Mode of operation.—The water passes into the cradle with a great rush, but before it reaches the hood end disappears entirely through the interlaced branches forming the bottom, leaving the fish high and dry in the hood.

Destruction of traps.—I destroyed a large number of these obstructions on my passage through the "Ditch."

Rebuilding time.—It is almost certain these traps will be constructed about August or September after the fish have run up.

Area where alone poaching is practised.—These cradle traps seem to be confined to the higher waters of this section as when the sides of the "Ditch" open out and tributaries increase the volume of water other methods are adopted but always in close proximity to a village or hamlet. In cases where new camps are formed by the people the trap building and poaching always occur. One of the main tracks crossing the Ditch to Mysore in the upper part of this section (about six miles from below Masinigudi) is a centre of poaching and from here down to Tallakuli several camping

grounds are to be found close to the river. One lot of the cradle traps were found near a hamlet called Velemenukudu.

Class of fish captured.—A large variety of valuable fish occupy this section comprising Carnatic carp, true mahseer, murral, eels and numerous other edible fish ; specimens of some I preserved. As my investigations were for the protection and improvement of rivers and not classification of fish, I only preserved the smaller variety that came to my rod or net.

Description of river below Tallakuli.—Proceeding down the Moyar from Tallakuli there is a succession or long deep reaches, gravelly runs and occasional islands with thick undergrowth harbouring numerous water snakes which greatly alarmed take to the water on the approach of the coracle.

The banks of the river where these long pools occur are lined with impenetrable creeper-covered trees, high coarse grass and thick jungle, broken by huge gaps in the places where elephants cross from side to side. For miles down the river is undisturbed by any poachers and there are no habitations. At one place two large trees of big girth had been blown down by some gale of wind and entirely span the river from side to side. They had evidently been there some considerable time as the floods had piled up all kinds of debris over them. These trees form an excellent foundation for constructing fish traps and could be made very effective at little trouble; it is advisable to have the obstruction removed, as when the people are prevented from poaching in the higher and lower reaches they are sure to give their attention to more inaccessible places and would certainly take advantage of this.

The river continues much the same down past Theppatturai (where a village used to exist but is now deserted) but occasionally opens out through more accessible country until Gazzalhatti is reached. Here I found evidence of poaching by patches of fish scales on the banks. There is only one man living here, the keeper of a dirty and dilapidated dak bungalow about a quarter mile from the river, but as it is a sort of meeting place of the few local inhabitants, they probably all poach.

Fishing here with a spoon I caught a small mahseer about 1½ lb. The contents of the stomach consisted of partly digested cray fish, some large mollusca and a lot of pulpy matter with small pieces of shell intermixed.

I was informed that at one time these reaches were well stocked with big fish but now through the use of dynamite and by other means are much depleted.

From here down to Pirkkadavu and on to Badapally where the Moyar enters the Bhavāni, the river is constantly netted. The people complained to me of the poor catches now, compared with former times. As the size of fish captured decreases they resort to smaller mesh nets. Taking the whole of this section of the Moyar I consider the poaching in the upper waters responsible to a large degree for the depletion of fish in this river.

Peculiar feeding habits of the carp in the Lower Moyar.—On examining a carp of about 2 lb. weight I found it gorged with the seed of the prickly-pear fruit. As this fruit grows some distance from the banks of the river and is impossible for fish to reach, I found some difficulty at first to know how they procured it till after careful observation close under some big trees an occasional splash of something dropping into the water followed by the swirl of a big fish, revealed the fact that the seed of this fruit actually passes undigested from monkeys and is eagerly eaten on reaching the water by these carp. Judging by a number of fish I procured here and examined, the seed seems to pass through them as well, entire, and without decomposition.

MINOR STREAMS.

Report on Parson's Valley stream, dated 10*th November* 1906.

Temperature, upper reaches, 58° Fahr. ... 9-30 a.m.
,, lower (falls) 60° ,, ... Noon.

Nature of the bottom.—Sand and gravel.

Fish food.—This stream is very prolific in live fish food, the following being largely in evidence, viz.—

Water beetles mollusca, crabs, caddis, indigenous minnows, and numerous animalcules and larvæ.

I netted the stream, at several stretches, and captured and examined three trout, viz.—

(1)	*Salmo irideus,*	13 inch,	male,	condition	very healthy.
(2)	,,	11 ,,	female	,,	,,
(3)	,,	10 ,,	,,	,,	,,

As the only nets procurable were very inferior and of large mesh, any smaller fish could pass through.

I consider this stream suited to *Salmo irideus* but it would have been much better if the upper reaches had been shaded by jungle. The tropical sun shining on exposed eggs on the spawning beds will destroy the life of the alevin. I therefore propose to remedy this by planting small shrubs in the upper reaches in the most suitable places for fry.

Report on trout in Parson's Valley stream, dated 29th June 1907.

I netted the upper reaches, 26th June 1907, and some of the deeper pools of this stream to ascertain if there were any young fish.

In the former I am pleased to report that I got four small rainbow trout about 3½ to 4 inches evidently from last January-February spawning.

This proves beyond doubt that the trout are now breeding and with the additional new blood I introduced last year they should increase rapidly after the next spawning season. The new blood will also improve and strengthen the future alevins, lessen the risk of interbreeding and firmly establish a healthy breed of trout.

The river will require careful watching to prevent poaching. Now that the bigger fish can be seen feeding in the shallow and narrow reaches it is a great temptation to the people to catch them. During the dry season when the waters are low this would be an easy matter as they frequent places where they could be caught by the hand.

It would be advisable after the next spawning season (which should be all over by end of March) to remove the very big fish to some other water.

The deep pools where these fish are found are most difficult to net. The banks in places are practically undermined with numerous holes where the fish take refuge, and the nature of the bottom is rendered so uneven by huge clumps of fallen earth from the sides that the odds are greatly in the fish's favour and against the net.

Report on Sandy Nalla stream, dated 16th November 1906.

Temperature at junction of Municipal stream, at 9-30 a.m., cloudy, 58° Fahr.

Temperature at noon (opposite Toda Mund), 60° Fahr.
,, at 1–30 p.m. highest reach in shade of jungle, 58° Fahr.

Nature of the bottom.—Gravel, sand and mud.

Animalcules, etc.—There is an abundance of minute life under the stones, immediately above the small tributary on the left going towards the source, three-fourths of a mile from the mouth or junction. Useful fish food was in some places (where the bottom of stream was mud) very scarce.

Class of food found.—Phryganea, Hydrophilus, numerous larvæ of above, indigenous minnow, crabs, etc.

Remarks.—On the higher reaches after the stream divides into three runners, there is on the main source an Irish bridge, which might prevent big fish descending from the spawning ground after the flood water had subsided below the level of stones. An opening could be made to allow the passage of fish. This is a small stream and not very suitable for trout as in the dry season the upper waters will be very shallow. If trout were introduced they would descend to the Municipal stream in dry weather.

Report on Municipal stream, dated 17th November 1906.

Temperature taken at ford below toll, bar on Pykara road at 9–45 a.m., bright sun ... ... 59° Fahr.
Temperature of side runner on right hand bank going down stream, 10–30 a.m. ... ... 58° ,,

Nature of bottom.—Mud, gravel, sand, covered in places with coarse weed.

Remarks.—This stream is very foul and dirty. In places weeds should be removed and an attempt made to introduce mollusca and other fish food into the lower reaches below the toll-bar which is at present deficient therein. The stream enters a thick shola and descends with a succession of small falls interspersed with good pools. Fish could pass down to these pools but not ascend again.

I consider that, in its present dirty condition, it is not very suitable for trout.

Report on Avalanche river, dated 24th November 1906.

Elevation above sea (about).	Temperature—Fahr., and time.	Name of places.	Date.	Weather condition.
FEET.		*Main river.*	1906.	
6,450	57° 8-30 a.m. ...	Ford	25th November.	Sunshine.
6,550	58° noon ...	Upper reaches	25th do.	Cloudy.
6,550	57° 7-30 a.m. ...	Do.	26th do.	Sunshine.
6,480	61° noon ...	Junction of Emerald Valley stream.	26th do.	Do.
6,400	60° 8-50 a.m.	McIvor's bund	26th do.	Do.
		Side streams.		
7,000	52° 7-25 a.m. ...	Stream in jungle behind Avalanche bungalow.	25th November.	Cloudy.
6,500	58° about noon ...	Stream over falls on right bank of Avalanche towards source.	25th do.	Do.
7,350	52° 6-40 a.m. ...	On Bangi Tappal road ...	27th do.	Do.

Nature of bottom.—Upper reaches, mostly gravel.

Fish food.—There is a fair amount of fish food in the upper reaches, but it is deficient in mollusca. Lower down near the junction of the Emerald Valley stream, large quantities of mollusca and numerous large larvæ are found.

I consider this stream should make a first-class trout river. I will transplant a quantity of mollusca from the lower reaches to the side runners in the upper waters. The higher reaches are naturally shaded in places, which is a great advantage.

The only fish life I could see in the river was the indigenous minnow and stone loach. Water was very clear.

The temperature in the upper waters is quite suitable for the natural breeding of rainbow trout.

(*Restocking with live fish food.*)

Avalanche river.

I proceeded to Avalanche on 11th February 1907 and visited McIvor's bund, then the junction of Emerald Valley stream, securing a large quantity of live food (mollusca) which I kept in damp sphagnum moss over night at Avalanche bungalow.

12th February 1907. Took above mollusca to the upper tributaries of the Avalanche river and stocked in suitable breeding places.

Report on the Emerald Valley stream, dated 12th February 1907.

Temperature, upper reaches—Noon, bright sun,			56°	Fahr.
,,	,,	3 p.m. ,,	58°	,,
,,	lower reaches—11 a.m.	,,	61°	,,

This stream rises in the hills opposite Avalanche and flows over a rocky and precipitous bed to the foot of the hills. From here downwards the nature of the bottom is gravel and sand and in the higher waters there is a fair amount of useful shade. There are good pools and the stream is very accessible for fishing.

I examined it thoroughly, but found no trace of trout, which were put in some years ago. The few that remained must have moved into the lower deep pools or have been poached. There was no evidence of any fish having been in the upper waters for spawning purposes. I examined the gravel beds in the upper waters where fry would most likely be, but found none.

The stream contains indigenous minnow, mollusca and small animalcules, a fair amount of shade in the high reaches, suitable spawning grounds with good temperature and very clear water.

I consider it should make a good stream for trout and, if carefully watched after stocking, they ought to breed in the upper waters as the temperature and nature of bottom are all that can be desired.

This stream joins the Avalanche river.

Report on Billithada Halla, dated 27th November 1906.

Elevation above sea (about).	Temperature – Fahr., and time.	Name of places.	Date.	Weather condition.
FEET.			1906	
7,560	52° 8 a.m. ...	Upper reaches	27th November.	Bright sun.
7,400	53° 8-40 a.m.	Junction, Notton stream.	27th do.	Do.
7,330	53° 9 a.m. ...	Junction, Bangi Tappal.	27th do.	Do.
7,150	61° noon ...	Beginning of falls ...	28th do.	Cloudy.
7,150	58° 9-25 a.m.	Do. ...	29th do.	Do.
7,150	62° 2-45 a.m.	Do. ...	29th do.	Do
		Tributaries.		
7,600	52° 7 a.m. ...	Notton stream	27th November.	Sun.
7,330	53° 9 a.m. ...	Bangi Tappal	27th do.	Do.

Nature of the bottom.—Upper reaches, gravel.

Fish food.—There is large amount of valuable fish food from the source to the falls.

The tributaries in the upper reaches are abundantly stocked with the larvæ of numerous flies, especially the Notton stream. This small stream would be most suitable as a spawning ground for trout, the temperature, the nature of bottom and natural shade in places are all that can be desired. The only fish I could see in the Billithada Halla were of the stone loach variety and indigenous minnow.

I consider this ought to make an ideal trout river and is the best I have inspected so far. Its high elevation, low temperature, good tributaries and the fact that it is out of reach of any likelihood of poaching are all in its favour. It is capable of carrying a large number of trout and their growth should be rapid owing to the quantity of feeding.

Report on Kil-Kotagiri streams (Kil-Kotagiri, Kengarai, Kagula and Guda Kul Halla), dated 16th January 1907.

The main "Kil-Kotagiri" stream rises above Kil-Kotagiri and flows into the Moyar.

Temperature, upper reaches, 56° Fahr., 9 a.m., bright sun.
,, lower down, 59° ,, noon, ,,

Live fish food.—This stream has a good supply of mollusca, larvæ and various flies and quantities of small animalcules.

Nature of bottom.—Gravel and sand.

I consider this small stream the most suitable one for the introduction of trout fry that I have seen in the Kotagiri district. It runs mostly through jungle with good shade and gravel bottom. The only fault is that it is so short, there only being about 3 miles of useful water, before it drops sheer down to the low country. If a few fry were introduced, they would doubtless thrive well until a certain age when they would move into the lower deep pools for greater protection and might eventually go over the falls. If careful supervision could be ensured, it would be useful to stock Kengarai and Kagula (tributaries of the Guda Kul Halla). Both of these streams have useful pools and in the upper waters a temperature of 56 degrees, lower waters, noon, 62 degrees. They all suffer by being so short and swift rising within a few miles of the sheer fall into the low country. They all have good shade and gravel bottom. The Kengarai stream has several falls, while passing through jungle which would render it very difficult for fish to get up to spawn, once they descend to the pools below. If fish were introduced, this could be altered to allow of easy access.

KOTAGIRI DISTRICT.

Report on St. Catherine Fall stream, dated 14th January 1907.

Temperature, upper reaches, 59° Fahr.

,, junction main tributary (5,650 feet), 60° Fahr.

Nature of the bottom.—Sand and gravel with clayey deposit.

Amount of live fish food.—Very little.

Remarks.—The main tributary of this stream has a rough stony bottom and has every appearance of washing completely out during rains. The banks of the main stream afford little protection for fish and are being gradually washed away.

At about 5,100 feet elevation, there is a big fall which is impossible for fish to ascend. The temperature below this fall is 63 degrees. The stream has a gravel bottom, but no shade or protective bank. Further down a stream from Kotagiri enters with a fair amount of shade and gravel bottom, temperature 60 degrees, 1-30 p.m.

I consider this stream unsuitable for trout, the banks being of such a nature that fish would not stay as they have no protection if disturbed, and the intervening fall would prevent them getting to the upper reaches to spawn.

Report on the Orange Valley stream, dated 15th January 1907.

Temperature, upper reaches, above falls, 57° Fahr., bright sun.

,,	,,	below falls,	11 a.m.,	58° Fahr.
,,	,,	,,	noon,	60° ,,
,,	,,	,,	3 p.m.,	61° ,, .

Nature of the bottom.—This stream in the upper reaches flows over slab rock. Below the falls the bottom is covered with a clay-coloured deposit and is very dirty.

Fish food.—The amount of fish food is very small and in places is practically all killed out by the above deposit.

There is one good tributary entering the main stream below Badaga village with a good supply of fish food and temperature 58° Fahr., at noon, bright sun.

This stream is not suitable for trout in its present condition, as the pollution or silt deposit on the bottom destroys most of the animalcules and valuable fish food.

Report No. 5 (1920).

NOTES ON THE TWO CICHLID FISHES OF MALABAR, ETROPLUS SURATENSIS AND E. MACULATUS

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INTRODUCTION.

The material on which these notes are based was collected chiefly during the years 1917 to 1920. The principal locality under observation was the shallow portion of the Astamudi backwater lying in front of the Fishery office at Quilon. Notes were also taken during the author's tours in different parts of the Travancore State for purposes of investigation. Breeders were introduced into convenient tidal ponds and kept there for three consecutive years and the habits of the two species were continuously studied. Feeding experiments were also conducted by keeping the young ones from their earliest larval stage in suitable glass aquaria.

Etroplus suratensis and *E. maculatus* are the only two representatives of the Cichlid family in Malabar. They are very common in all backwaters, river-mouths and brackish-water ponds and lakes. In rivers they are not rare ; the first species is found to breed freely as far as tidal limits, but although sometimes during the hot season they migrate beyond these limits, they are not ordinarily found to breed there ; the second species breeds freely in fresh-water. In Travancore these are the principal food-fishes obtained from inundated paddy fields near river-mouths.* Their favourite haunts are shallow creeks of backwaters and canals where there is a luxuriant growth of aquatic vegetation. E. suratensis is sometimes introduced into fresh-water tanks to keep down the growth

* On the Coromandel coast, E. suratensis is not known to haunt paddy-fields ; in Travancore these fields are, however, inundated to a greater depth and for a longer period—J.H.

of algæ. This species is noted for its elegance of movement and tameable habits; it is well suited for stocking tanks and lakes, owing to its fair size, palatability, hardihood and non-predaceous nature.

Although both species are quite common in the maritime regions of the Madras Presidency and of Ceylon, very few investigators seem to have paid much attention to them. Dr. A. Willey (7) has published observations upon the breeding habits of E. suratensis. Thomas (6) and Sundara Raj (5) have also given a number of facts concerning both of them. The note which follows is a contribution to a fuller knowledge of their reproduction and life-history.

1. ETROPLUS SURATENSIS *(Bloch).*

Malayalam—*Karimeen* = Black-fish.

HABITS AND CHARACTERISTICS.

Nest making.—During the breeding season the fish resort in pairs to shallow shady places and make a search for a suitable object upon which to deposit the eggs. Stones, pieces of wood, coconut husks, or midribs of coconut leaves, submerged at a depth of not more than three feet of water, are preferred. If the surface selected is smooth as is the outer rind of coconut husk, it is made rough by biting on it in order to raise short fibres. After selecting the object one side of it is made clean by biting away all dirt or vegetable growth. If the object is found not to be raised sufficiently from the ground to afford convenience for the spawning movements, a broad cup-like excavation is made in the ground just below the surface selected by taking the mud and sand in the mouth and blowing them away. Although each of the pair takes part in the preparation of this simple nest, the male is found to attend to it more particularly. The pair spend three to five days in selecting the place and in preparing it for the reception of the ova.

Egg laying.—The female lies flat in the cavity or space adjacent to the surface prepared and gently moves from one side to the other attaching the ova one by one in a single layer. In doing so the urino-genital papilla, here so elongated as to deserve to be termed an "ovipositor," is placed in contact with the surface, and the black ventral fins are brought together to press on it gently to help the extrusion of the egg. After five or six such operations she

retreats, and the male by a similar but quicker movement pours his milt over the eggs and fertilizes them. He also scrutinizes the eggs before he allows his mate to approach the nest again and impatiently watches her while she lays her eggs. The spawning lasts about two or three hours during which the alternate processes of egg-laying and fertilizing take place several times. Both the parents try to drive away any fish approaching the nest. They fondle each other by striking each other's side with the snout and by rubbing sides. This is also a very common habit with the fish when they are at play. The eggs are cemented to the prepared surface in a single layer close together but not in actual contact with each other. The number found in a nest varies within wide limits from over three hundred to more than a thousand. Young adults are less prolific than the older.

Care of the eggs and the young.—After the eggs are laid and fertilized the female broods over them. She is found almost always close to the nest, fanning it with her pectoral fins and scrutinizing the eggs from time to time. The current produced by the pectoral fins puts the eggs gently in motion and prevents any sediment sticking to them. Occasionally the mother goes in search of food, leaving the charge to her consort, but she is never away for more than ten minutes. The male generally remains a little away from the nest and keeps off all intruders from it ; but unlike the female he makes long excursions for feeding. On the fourth day after spawning he begins to excavate one or two pits at some convenient place near the nest. Generally he selects the nearest place where the bottom is not more than three feet below the surface and where it is of fine sand firmed with mud so that the pit excavated may not be filled up with sand and mud falling in from the sides. He tests the ground well by scooping at different places before he selects the proper place. Sometimes it may be more than ten feet from the brood. The female also takes part in digging pits. They are about two to three inches in diameter and about one inch or a little more in depth. After the larvæ are removed from the egg membrane to one of the pits as described below, more of these pits are prepared in the bottom around. The fish takes the mud and sand from the ground and blows them away at a distance. Even pebbles of some weight are thus thrown away.

Before the eggs begin to hatch the pit is made ready. The female is then seen anxiously watching the hatching eggs and incessantly fanning them. The hatching takes place on the fourth or fifth day after spawning. The newly hatched larvæ attach themselves for a time to the egg membrane whence they are picked up by the mother in her mouth and transferred to the pit. As the hatching proceeds vigorously she carries large numbers at a time. The male also helps her occasionally, but his attention is given chiefly to the larvæ deposited in the pit. The time taken for the hatching of the whole brood is never more than twenty minutes. When all the young ones have been transferred to the pit, the female keeps close watch over them and drives away intruders. The male remains by her side and occasionally relieves her for feeding. A constant current is produced near the pit by the active fanning with the fins of the attendant parent and by the incessant vibration of the tails of the larvæ within the pit. The caretaker often examines the larvæ by poking its nose into the pit and carefully removes all foreign particles entering it. The young ones are transferred from one pit to another at least once a day.

The habit of these fish in taking the young into the mouth and carrying them from one nest to the other, is very interesting in view of a similar habit of buccal incubation observed in some of the African and American Cichlids. To my surprise, I found one day the pit from which I took some larvæ for observation some hours previously, was deserted by the guardian fish, which was found guarding another new pit some feet away from the old one. I examined the new pit and the larvæ were found not to have grown to the free-swimming stage. This induced me to try the experiment of removing some larvæ from the pit by means of a glass tube and dropping them outside. The guarding parent immediately picked them up carefully and deposited them again in the pit. This conclusively proved that it was the parent fish which transferred the young ones to the new pit. Later I had occasion several times to observe the spawning and hatching of the eggs and the transference of the larvæ from the egg membrane to the pit and also from one pit to another. In Etroplus maculatus also the same habit was observed several times.

Dr. Boulenger in describing the care of the young by the female Cichlids of Africa observes as follows :—

" . . . So far as I could speak from personal observation . . . it is invariably the female who thus carries the eggs This was in contradiction to statements made by Lortet and by Gunther who ascribed this habit to the male in the species of the same genus with which they had dealt . . . It therefore remains unproved whether in any of the African or Syrian Cichlids the buccal incubation, as it has been called by Dr. Pelligrin, devolves on the male."

On all possible occasions I have taken care to ascertain the sex of the fish which carry the young by actual observation of the spawning and also by the examination of the genital glands ; I am convinced that, although the male helps his mate in carrying the young from nest to nest, this duty is mainly performed by the female.

When the yolk sac is absorbed and the pectoral fins become functional, the larvæ are led out by the parents to the neighbouring open water. The female gathers them round her and the male guards them against intruders. If frightened or otherwise disturbed, the larvæ take shelter in some hollow in the ground or cling to bottom debris or under the parents' fins. For the first four days they are collected together at sunset under the ventral fins of the parents and led to some hollow where they are kept for the whole night carefully guarded. The black ventral fins are very useful in guiding the young ones and it is interesting to see the parent fish attract their attention by rapidly spreading and closing these fins twice or thrice. Mouth to mouth fighting is often found to take place between parents belonging to different broods and also against wandering members of the same species. The parental care lasts for a considerable time even after the young ones assume the adult form. They feed chiefly on minute animal life found in the bottom debris or hiding among mossy growth. They seem to take vegetable food only after entering the late larval stage. After leaving the last pit they are never found to be picked up by the parent in the mouth.

The fish becomes sexually mature in the second year of its life. It breeds twice a year, in May to June and again from November to February, the maximal spawning being in January. A pair singled out and kept in the experimental fish-pond, spawned first in May 1917 and again in November of the same year. Spawning

takes place generally when strong sunshine follows continuous heavy rains during a few days. Late spawners seem to breed only once a year.

During the breeding season the colour bands of the parents become conspicuous, the anal as well as the ventral fins become black, and black spots or blotches appear in groups on the ventral side between the ventral and caudal fins at the lower ends of the black stripes. The colour patches of the male are more strongly marked and darker, when the young ones are taken about for feeding. The greenish-blue iridescence and the pearly white spots become more vivid, and the rayed portions of the dorsal and anal fins turn a little red before spawning, which colour disappears when the young reach the late larval stage. The female is generally smaller and assumes a muddy yellowish-brown colour before spawning when the "ovipositor" develops; the latter is sometimes a little more than a quarter of an inch in length.

This fish breeds in shallow, shady portions of backwaters where there is an admixture of fine firm sand and mud at the bottom. It prefers places where coconut husks are soaked. It is also found to breed freely in all brackish-water ponds, ditches, canals and even in paddy fields.*

LIFE-HISTORY.

The eggs.—The egg is oblong in shape, the length being twice its breadth. It is attached at one end by means of a short stalk to the object used as a nest. Newly laid eggs are yellowish in colour. They become brownish as the embryo develops and the yolk sac becomes pigmented. They are about 2×1 mm. in size. The period of incubation lasts from 82 to 100 hours. The egg membrane bursts first over the head of the larva which is at the free end and the split continues along the upper side by the waving of the tail. For a moment the newly hatched larva remains attached to the egg membrane by means of its cement organs. The guardian fish then picks it up and deposits it in the pit.

Early larval stage.—The newly hatched larva is 5 mm. long; it has neither mouth, gills, nor paired fins. The eye is pigment-

* On the east coast it also breeds naturally in purely fresh-water lakes at some distance from the coast; the Red Hills reservoir and Kolavoy tank at Chingleput are instances. It is also now acclimatized by the efforts of the Fisheries Department in lakes far inland, such as at Kurnool, where it breeds freely—J.H.

less, but the auditory organ is distinctly developed. The yolk is richly pigmented. The larvæ group together in the centre of the pit and attaching themselves to small particles of sand by means of the cement organs, they incessantly vibrate their tail. If disturbed, they move about with the yolk sac upwards and soon rearrange themselves as before. The instinct to group together and to vibrate the tail lasts till the yolk sac is fully absorbed.

Second day.—Pigment in the eye appears.

Third day.—6 mm. long. The mouth opens, and the yolk sac is reduced to half its size ; a dilatation in front of the yolk sac at the cardiac region appears. Heart beating is more vigorous and the respiratory movements begin.

Fourth day.—Pectoral fins appear, colour pigments appear on the back at two centres.

Fifth day.—The yolk sac is almost absorbed, dilatation in front of the yolk sac disappears and when the larva moves, it lies over on one side.

Seventh day.—7 mm. long, yolk sac wholly absorbed, tail fin still continuous with the dorsal and ventral ; the larva leaves the nest and moves about in its neighbourhood, guided by the mother, in quest of food. Cement organs wholly disappear.

Late larval stage.—The larva even after leaving the nest is quite different from the adult fish in form. The tail remains long and the caudal fin is continuous with the dorsal and anal. These fins begin to separate only from the fourth day after the larva has entered the second stage. About a fortnight afterwards, the primary chromatophores on the back disappear and permanent colour bands begin to appear. The larva assumes the adult form within a month after hatching, when it is about 18 mm. long. The ocellus on the soft rays of the dorsal fin appears distinctly. The young ones continue to be guided by the parents till they are about an inch and a quarter long, which size they attain in about two months. Even when they are out of the care of the parents they group together in shallow places.

Until the larvæ attain the adult form and the bones develop they are preyed upon by both young and grown-up individuals of the same species. The larval nest is sometimes attacked by them in groups, especially when they are kept under confinement. The parents attempt to defend the nest by moving round it in circles, but they are pushed aside and the nest is emptied of its contents.

Under natural conditions such determined attacks are very rare. This cannibalistic tendency can be reduced by supplying them with animal food in the form of chopped prawn or crab. E. maculatus, gobies and crabs are other natural enemies to the larvæ. If one of the parents is separated, the other becomes disgusted with the unaided care of the brood and soon wanders away leaving them to themselves. The male can be easily allured by throwing food at a distance, but the female takes the brood with her. The larvæ, if separated from the parents' care and reared under artificial conditions, soon turn anaemic and die.

Although these fish are found in large numbers near the mouths of estuaries, none of them dares to enter the sea. When living under adverse water conditions the fish turns more and more blotched with black. The colour deepens with the increase of salinity or density of the water. The same is the case when it is put in water boiled and cooled and the colour becomes light when the water is again well aerated. Although its adaptability to varying conditions of salinity is wonderful, it is not immune to bacterial or fungoid attacks. In one of my fish ponds into which water percolates during the rainy season from the land side, bacterial growth becomes enormous and the fish kept in it become subject to the attack of a kind of bacterial disease and, if the pond is not supplied daily with a current of saline water from the adjoining backwater, all of them die within a few days. If the affected fish are let out into the backwater they soon recover.

Under favourable conditions within five years the fish grows to rather more than a foot in length and weighs about three pounds. Among backwater fishes it is the most esteemed in Travancore as a food-fish and fetches the best price.

2. ETROPLUS MACULATUS *(Bloch).*

Malayalam—*Pallathi, Kurumpad* = "Short striped."

This small cousin of E. suratensis is very common in all waters of the plains of Malabar; especially in paddy fields, shallow canals and ditches. It migrates far higher up rivers and breeds freely in them beyond tidal limits. In the power of endurance and activity it surpasses its relative. Colour-change coincident with alteration in the density of the water, is also marked in this species. It moves about in schools consisting of individuals of different ages. During the early part of the monsoon season after the first

freshes, large numbers of them are found to migrate to the inundated paddy-fields and irrigation channels. Most of them then put on an attractive yellow livery. They breed freely in all waters they choose to occupy. The breeding seasons almost correspond with and the breeding habits are just the same as those of E. suratensis. It becomes sexually mature at the close of the first year of its growth. It is more active and pugnacious during the breeding season than E. suratensis. The female is smaller and more deeply coloured than the male. Mr. Sundara Raj (5) has described in detail the breeding habits, the nest, the eggs and the larvæ of this fish and I have therefore to note here only certain facts amplifying his statements.

The eggs are always attached to submerged objects, preferably small stones, old leaves or stumps and dead roots of coconut trees. If the object is not raised a little from the ground, a small excavation is also made adjacent to it. The eggs hatch on the third or fourth day and the larvæ attach themselves to the egg membrane for a short time. They are picked up from there and deposited in pits prepared for the purpose. These excavations are about an inch or two in diameter and an inch or a little less deep at the centre. None that I have seen has been lined with algæ. New pits are prepared from time to time and the larvæ transferred thereto in turn. Mr. Sundara Raj describes a curious habit of the parent of what appeared to him to be a feeding of the fry. I have also observed the parent going to some selected spot, preferably near the root of a plant or the side of a submerged stone or stick and digging with its mouth. This is, however, only for the preparation of a new pit. The sediment collected is never thrown into the nest which is always kept clean. On the third day after hatching the mouth is formed, and on the fifth or sixth day the larvæ leave the pit and move about in the neighbourhood in quest of food. The yolk sac is then almost absorbed and the cement organs disappear. Except for the difference in size it is very difficult to distinguish the young of E. maculatus from those of E. suratensis before the transverse colour bands disappear in the former.

REFERENCES.

1. Annandale, N.—"Report on the Biology of the Lake of Tiberias," *Journal As. Soc. Bengal* (N.S.), Vol. XI, Nos. 10 and 11, 1915, pp. 464–65.

2. Boulenger.—"Fourth contribution to the Ichthyology of Lake Tanganyika," *Trans. Zool. Soc. London*, Vol. XVII, 1906, pp. 537—76.

3. Boulenger.—"Cichlidæ of Africa," *Cat. Afr. Fishes*, III.

4. Gill.—"Parental care among Fresh-water Fishes," *Smithsonian Inst. Rep.*, 1905, 1906, pp. 403—531.

5. Sundara Raj, B.—"Notes on the Fresh-water Fish of Madras." *Rec. Ind. Mus.*, Vol. XII, 1916, pp. 282--86.

6. Thomas, H. S.—*Report, Pisciculture, in South Kanara*, 1870.

7. Willey, A.—"Notes on the Fresh-water Fisheries of Ceylon," *Spolia Zeylanica*, VII, p. 102.